BULLETIN 600 FEBRUARY, 1939

PROGRESS

OF

AGRICULTURAL RESEARCH

IN

OHIO

1937 - 1938

FIFTY-SEVENTH ANNUAL REPORT

OF THE

OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO

FOR THE YEAR ENDING JUNE 30, 1938

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The Honorable Harry A. Caton
President of the Board of Control
Ohio Agricultural Experiment Station

Dear Sir:

I have the honor to present to the Board of Control for transmission to the Governor of Ohio, as required by law, the fifty-seventh annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1938.

Edmund Secrest
Director

The Honorable John W. Bricker
Governor of Ohio

Dear Sir:

I have the honor to present to you the fifty-seventh annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1938.

Harry A. Caton
President, Board of Control

PROGRESS OF AGRICULTURAL RESEARCH IN OHIO

The Ohio Agricultural Experiment Station is a department of State government whose province is to develop the science of agriculture. Its staff of workers is dedicated to the task of solving the problems of agriculture by careful and fundamental research.

The agronomic work covers the restoration and maintenance of soil fertility, hybridization and selection to improve the quality and yield of field crop plants. Experiments are in progress to determine the species and varieties of grasses best suited for lawns and golf courses, rates and time of seeding, methods of fertilization, watering, and clipping for best results, and the control of weeds.

Livestock is a major investment on many Ohio farms, and the Experiment Station's projects include nutrition and feeding, crossbreeding to improve the quality and vigor of beef cattle, swine, and sheep. Considerable progress has been made in the field of poultry management, and in nutritional factors affecting the production, hatchability, and shell texture of eggs, and the feasibility of confining laying hens permanently in cages as compared with freedom in laying houses.

Projects relating to the control of devastating animal diseases, such as mastitis and Bang's disease, and more positive methods of hog cholera control are under way at the Animal Disease Laboratory in cooperation with the College of Veterinary Medicine, The Ohio State University.

The dairy industry is at the top in Ohio, and it is confronted with many problems both in economics affecting the industry and in the management of dairy herds. The Station has under way research projects relating to both. Effectiveness and economy in feeds always will be an important consideration in milk production. But equally important is the maladjustment in marketing, distribution, and disposal of surplus milk. Progress has been made in increasing the vitamin D content of milk, and in the effect of pasteurization on the nutritive value of milk.

The field of horticulture includes perhaps the most highly specialized growers in agriculture, and as such, the industry is besieged with a multiplicity of problems. The commercial apple orchard has almost entirely superseded the farm orchard, and from the production aspect the orchardist is confronted with the problem of controlling diseases and insect pests, maintaining the fertility of the soil in order to produce the quality of fruit that will be accepted on the market at the low prices that have prevailed for several years past. Economy in production of high-grade fruit is a major consideration. Apple growers in common, need to find new uses for their product, and very definitely there is need for better distribution and marketing methods.

Ohio leads in the production of vegetables and flowers under glass; the investment is some $25,000,000. Here the problems relate largely to improved varieties, fertilization, the control of insect infestations and diseases that occur in great range and intensity.

Projects in rural economics include marketing research, factors affecting profitable farm organization, adjustments in farming relating to agricultural

adjustment, and factors influencing soil conservation. Population movements as between country and city, and resultant levels of living have an important bearing on agricultural adjustment, as well as on ultimate standards of living.

The average farm has need for engineering services. Improved and more economically maintained building structures, adequate and verminproof storage facilities have a place in modern agriculture, and would result in savings and efficiency in farming operations. The development of many types of modern power machinery and certain phases of rural electrification are well within the province of agricultural engineering and are recognized by the Experiment Station.

Plant diseases annually take great toll of farm crops, fruits, flowers, shade and forest trees. Investigations in the study and control of plant diseases have been carried on for many years by the Ohio Station. These problems have been attacked by the application of poison sprays, plant breeding to develop resistant strains, and methods of culture and crop rotation which have often proved effective.

The control of insect infestations quite analogous to disease is of great economic importance to farmers and urban property owners in Ohio. Such destructive insect pests as the San Jose scale on fruit trees and many species of ornamentals, the codling moth or aphis, the Oriental fruit moth, the European corn borer, the wireworm in potatoes, are pests of economic importance to growers. Methods for their control are projects of the Experiment Station. Plant breeding has a definite role in the control of both diseases and insect depredations through the development of resistant varieties. Other means of biological control are proving their worth.

The work of the Experiment Station extends to every section of Ohio. The 16 district and county experiment farms include in large measure the soil types of the State and the adapted crop plants. Many lines of investigations are being conducted on these outlying farms and they offer opportunities for trials of findings and for work essentially of an exploratory nature. In all, some 3,400 acres of land are involved in the program of the Ohio Station. The district and county experiment farms have made valuable contributions in changing agricultural practices.

In addition to publicly owned farms much work of an exploratory nature, in the form of short-term experiments, is being conducted in cooperation with growers on their own lands. This type of work has been satisfactorily carried on with commercial orchardists and greenhouse operators, particularly in the control of insect pests and plant diseases. Various land operators have rendered special services in corn and wheat breeding projects, and the State Welfare Institutions have made it possible to undertake investigations with dairy herds, and projects in forestry and horticultural subjects.

THE OHIO SOIL SURVEY

A reconnaissance soil survey of the entire State was completed in 1912. This survey was of a general nature and has proved of much value. Detailed basic surveys are essential in shaping agricultural practices. Subsequent to the general survey, 31 of the 88 counties in Ohio have been surveyed in detail, and maps prepared to show the character and agricultural value of the soils and their distribution.

It seems advisable to call attention to the importance of completing this project at an early date. There is an essential need from many sources for the information which the detailed survey will disclose. It is basic to land use programs and readjustment policies now in the making. Increasing requests relative to the soils in different parts of the State are coming to the Station. A complete knowledge of our soils and their distribution is an essential basis for changes involving agriculture, forestry, and conservation, and in agricultural research and education. It is desired at this time to emphasize the need of financial support for this important project.

As agriculture becomes more specialized, new problems arise to harass the growers, and the requests for assistance are beyond the means of the Station to supply, both in personnel and equipment. Careful evaluation of projects before they are initiated is essential in order that the resources of the Institution may be distributed over the field of work and applied to efforts which promise the most far-reaching results.

STAFF APPOINTMENTS JULY 1, 1937, TO JUNE 30, 1938

O. A. Alderman, Chief, Department of Forestry

O. D. Diller, Assistant, Department of Forestry

L. C. Chadwick, Assistant, Department of Horticulture

Carl H. Bradford, Shepherd, Animal Industry Department, vice H. H. Knupke, resigned

Norman F. Childers, Assistant, Department of Horticulture

Mary Brown Patton, Assistant in Home Economics, raised to rank of Associate

F. J. Shulley, Assistant, Department of Forestry, vice B. E. Leete

Charles R. Donham, Associate in Animal Industry

Irving I. Dickman, Ranger, Dean Forest

Benjamin H. Bentley, Ranger, Pike Forest

S. T. Newcomb, Ranger, Nelson Ledges State Park, vice A. D. Hannah, resigned

John Bastian, Assistant, Department of Forestry, vice F. J. Shulley, resigned

J. T. McClure, Climatology Observer, vice C. A. Patton, retired

Florence Petzel, Assistant, Home Economics Department, vice Marion Griffith, resigned

Paul Loiselle, Assistant, Agricultural Engineering Department, vice I. P. Blauser, resigned

Nicholas Alter, Foreman of greenhouses and grounds, vice G. R. Mann, resigned

C. H. Martin, Assistant, Department of Entomology

AGRONOMY

REBUILDING ERODED LAND AIM OF NEW EXPERIMENT

"How valuable is topsoil?" and "How best rejuvenate eroded land?" are questions whose answer is sought in a new experiment at Wooster.

At the start, 10 inches of topsoil were scraped off a half-acre tract of virgin Canfield silt loam and spread uniformly over a similar area near by. Another half-acre tract was left as it was. Across all three tracts were started in 1937 11 different cropping and soil management systems ranging from highly depleting to strongly conserving. Without fertility treatment the normal soil produced 77 bushels of corn in 1937 and 61 bushels of oats in 1938. Corresponding plots of the eroded section produced 13 bushels of corn and 7 bushels of oats—eloquent testimony of the value of topsoil.

Oats following sweet clover green manure yielded 59.5 bushels per acre, left. Oats following corn yielded 7 bushels per acre, right. Both crops grew on eroded soil.

Excellent crops of sweet clover were grown on two of the eroded soil plots in 1937 from spring seedings made after liming to neutrality and applying 6 tons of manure and 300 pounds of 0-14-6 fertilizer per acre. On one of these plots the sweet clover was plowed down for green manure and oats seeded in the spring of 1938. The oats yielded 59.5 bushels compared with only 7 bushels on an adjacent plot, also on eroded land.

NEED FOR "EXTRA PLANT FOODS" NOT ESTABLISHED

Farmers who have been urged to pay 2 or 3 dollars more a ton for fertilizers carrying "extra plant foods" will be interested in crop yields from a Wooster experiment in which rather generous amounts of each of six "minor

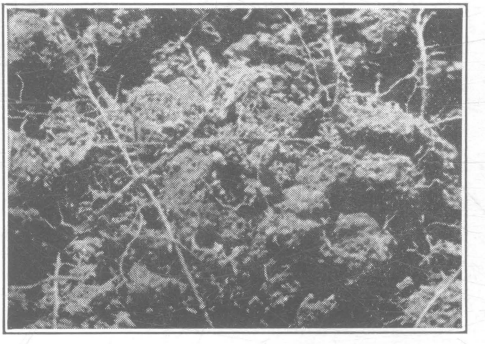
elements" have been supplied as additions to 300 pounds an acre of a 2-12-6 fertilizer on a soil that had been farmed for many years and was in a depleted condition at the start of the test. The almost negligible results shown suggest caution in investing in "extra plant foods" until their need has been proved for any given crop and soil condition.

Annual acre treatment	Bushels per acre of—		
	Corn, 1936	Oats, 1937	Wheat, 1938
300 pounds of 2-12-6 in pure chemical salts	39.3	24.7	23.0
Same plus manganese (as sulfate, 50 lb.)	38.6	24.9	21.9
Same plus copper (as sulfate, 50 lb.)	38.6	24.9	20.9
Same plus magnesium (as sulfate, 50 lb.)	38.0	24.6	23.2
Same plus zinc (as sulfate, 50 lb.)	38.8	25.0	23.4
Same plus sulfur (as gypsum, 200 lb.)	38.6	25.9	25.4
Same plus boron (as borax, 5 lb.)	40.0	25.6	25.8

STUDY SOIL STRUCTURE REQUIRED FOR SUGAR BEETS

How to create and maintain the open, granular soil structure required for high sugar beet yields is the object of new studies begun at Holgate in 1938.

Preliminary observations showed one-seventh more pore space in soil growing excellent beets following plowing of virgin soil than in adjacent old cropped land growing mediocre beets. The difference appeared due to grass roots holding soil granules together and preventing their breakdown under the influence of rain and tillage.



Soil granules held together by roots of bluegrass sod

Note the roundness of the granules and the large number of roots.

Surface applications of straw and manure also helped to keep the soil friable and loose and gave increased yields over adjacent untreated plots.

SOYBEANS SHOW SMALL RESPONSE TO FERTILIZERS

Soybeans outrank other crops in their ability to extract mineral nutrients from the soil. At least they have failed to respond to fertilizer additions on soil at Wooster which has usually shown high response with other crops. For 4 consecutive years various fertilizers have been applied to soybeans at the rate

of 200 pounds per acre, in some cases drilled in with the seed and in others drilled as a separate operation ahead of planting. Drilled with the seed, all fertilizers containing nitrogen or potash injured the germination. Drilled in ahead of seeding, they have not affected the stand. Regardless of fertilizer used or method of application, in no case has the yield been increased significantly.

WEATHER AFFECTS RETURNS FROM TOP-DRESSING WHEAT

Whether spring top-dressing of wheat with nitrogenous fertilizers yields profit or loss appears to depend upon the kind of winter weather preceding the season of harvest. Supporting this observation are results obtained in a 9-year Wooster test in which April applications of sulfate of ammonia or nitrate of soda have produced excellent increases in some years, little or no increase in others. Especially poor were the results in 1931, 1934, and 1936. Weather records for October to April show that rainfall was about half normal preceding the harvests of 1931 and 1934. Preceding the 1936 crop the winter was extremely cold and the soil was frozen 3 feet deep. Both conditions tend to prevent leaching out of available soil nitrates. On the other hand, following wet or open winters, spring dressings of 100 to 150 pounds of sulfate of ammonia have been generally profitable.

DRYING AFFECTS POTASH FIXATION IN SOILS

That drying of soils after applications of potash fertilizers may result in the potash being locked up in unavailable form is indicated by recent laboratory studies. The explanation is found in changes taking place in the fine clay particles. X-ray studies show that these minute particles are really small flat crystals each made up of a series of different sheets or plates. When the clay is wet, water enters between these sheets causing the crystal to expand. Such nutrient elements as potassium move in between the sheets and become attached to the sheet surfaces. When the clay dries out the sheets move back together locking the potassium atoms firmly between them. Part of this potassium is released if the clay is rewetted, although considerable time may be required for this to take place.

THE SOIL SURVEY MAKES PROGRESS

The inventory of Ohio's most valuable natural resource, the soil, is progressing. Field operations of the Soil Survey in 1938 were confined to Tuscarawas County, where soil, erosion, slope, and land-use surveys were completed and reported. Watersheds above flood control dams in Indian Fork of Connotton Creek and in McGuire Creek (Carroll County) have been similarly surveyed by the Soil Conservation Service, as has also the erosion control demonstration project area above the Senecaville Reservoir (Noble County).

Soil survey reports and maps for Licking and Vinton County were published during the year. Reports for Adams and Athens Counties are "just around the corner." Published reports can be obtained from the Experiment Station.

LIME INCREASES ALFALFA IN MIXED SEEDINGS

How the proportion of alfalfa in a mixed seeding increases with the amount of lime applied to an acid soil was demonstrated in the Liming Materials Experiment at Wooster in 1937. Here a uniform seeding of 4 pounds each of alfalfa, red clover, and timothy and 2 pounds of alsike clover was made in wheat on all plots. The following table tells the story.

Pounds of limestone applied every 3 years	pH of soil in 1937	Pounds of hay harvested in 1937	Percentage of alfalfa in the hay
0	5.1	1,870	0
500	5.4	3,100	6
1,000	5.6	3,920	12
2,000	6.3	4,480	24

TEST VALUE OF SOYBEAN MEALS AS GRASS FERTILIZER

Soybean meal is good feed for grass as well as for cows, a fact well shown in the Station's turf fertilizer experiments. Chief merits are its freedom from burn and the more gradual release of nitrogen, compared with such quick-acting mineral fertilizers as sulfate of ammonia. Before 1938 the soybean meal tested was that made by the "expeller process", containing only a small part of its nitrogen in water-soluble form. Turf tests at both Wooster and Columbus in 1938 included a comparison of "expeller process" meal—nitrogen 17 per cent soluble—with the newer "hot solvent extraction" meal—nitrogen 35 per cent soluble—and the still newer "cold solvent extraction" meal—nitrogen 70 per cent soluble. Unexpectedly, no significant differences showed up either in total recovery of nitrogen by the grass or in the distribution of the effect during the season. All three gave excellent results.

WHEAT YIELD CUT FOLLOWING COMBINED SOYBEANS

At Wooster wheat following combined soybeans yielded in 1938 only 27.7 bushels compared with 34.3 for wheat after binder-harvested soybeans and 36.9 bushels after soybeans cut for hay. The wheat was all sown on October 9. During its spring growth the wheat following combined soybeans was of a lighter green color than the other wheat, indicating a shortage of available nitrogen. Crops generally suffered from nitrogen deficiency in the spring of 1938 and it seems probable that the residue of soybean straw left after combining accentuated this deficiency. Soybean straw contains relatively little nitrogen and its effect in this case was probably similar to that often observed from additions of such low-nitrogen residues as small grain straw and corn stover.

CORN HYBRID PROGRAM GAINS MOMENTUM

Ohio is swinging rapidly to corn hybrids. Of the State's total corn acres, 2 per cent in 1936, 8 per cent in 1937, and 40 per cent in 1938 were planted to corn hybrids developed by or introduced through the corn breeding project of the Ohio Station and the United States Bureau of Plant Industry. Ten thousand individual field plots were devoted to corn breeding and testing in 1938.

Extensive breeding nurseries for the development of inbred lines[1] have been maintained in Wayne and Ross Counties. Here emphasis has pointed toward the assembling of valuable germ plasm into fewer lines. For example, Ohio 51, an inbred line carrying excellent factors for yield and resistance to smut and certain rot fungi but susceptible to heat injury and lodging, has been improved by introducing into it heat and lodge resistance from Ohio line 17. Breeding for disease resistance gains in importance, although already much progress has been made, as shown by the fact that hybrids now in use average only one-fourth as susceptible to smut as open-pollinated varieties. Differences observed among inbred lines and hybrids in their susceptibility to stalk rot, so widespread in 1938, promise almost certain success in future breeding for stalk rot resistance.

More complete information on local adaptation of new hybrids has been the object of 25 tests on private farms and 9 on experiment farms, each comprising 20 strains including certified Ohio hybrids, hybrids advertised by out-of-state firms, experimental hybrids, and a few open-pollinated varieties. Eighteen additional cooperative tests of a more preliminary nature, including two tests of corns for silage, bring the total number of official tests to 52. The results of all tests will be summarized and published as a guide to farmers purchasing seed.

MEASURE RATES AT WHICH CORN HYBRIDS GROW

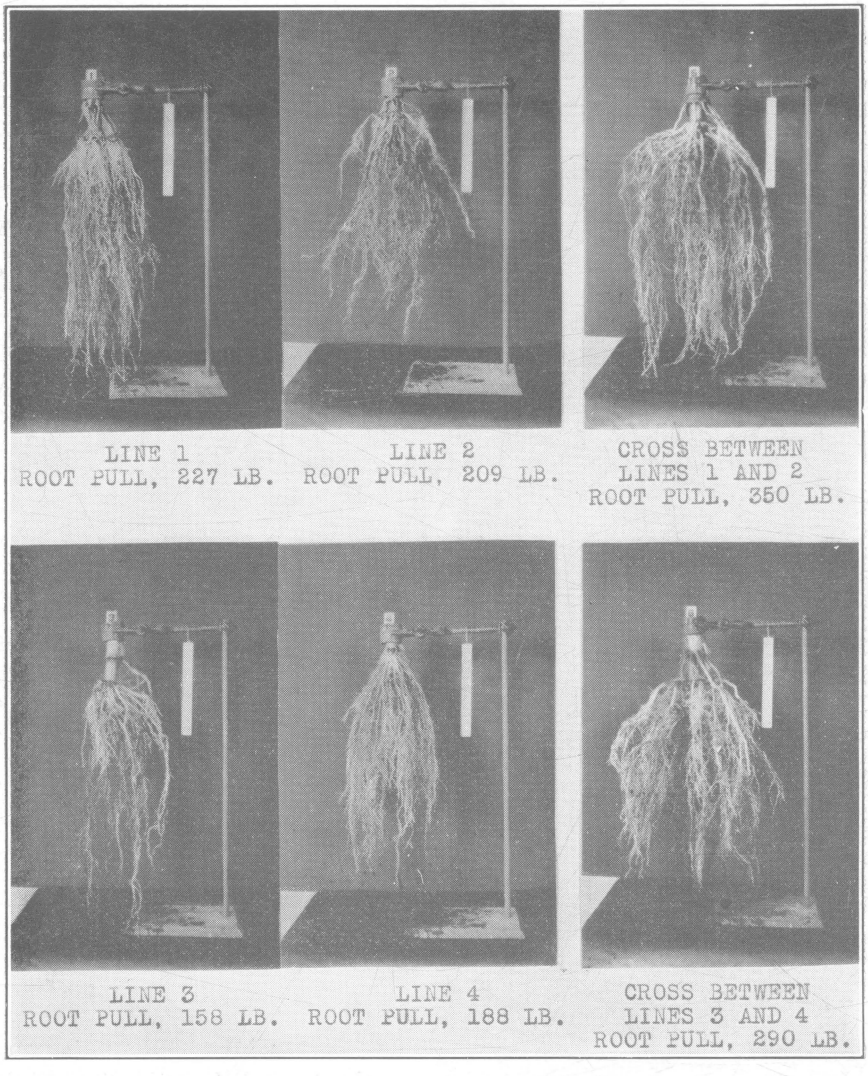
Tall stories about corn growing 6 or 8 inches overnight may have to be tamed down according to growth records taken at Wooster on a number of fast-stepping hybrids during July, the month of most rapid growth. On highly fertile soil the daily average inches increase in height were: K23, 1.8; K35, 1.9; W17, 2.0; Iowa 939, 2.1; and U. S. 65, 2.4. Rate of increase in weight of plant was also determined for one hybrid, K35, by harvesting and weighing plants every 2 days. During most rapid growth this hybrid produced dry matter at the rate of 155 pounds an acre each day. The actual green weight of the plant increased 575 pounds an acre a day. The difference, 420 pounds, was, of course, water stored in the plant tissues.

BREEDING CORN WITH STRONGER ROOTS

Storm-flattened corn fields are becoming rarer as corn hybrids spread over the State. Generally much superior to open-pollinated corns, the hybrids still vary in lodge resistance. Breeders are constantly trying to build new corns with stiffer stalks and more vigorous root systems.

Determinations of the breaking strength of stalks and of the pulling resistance of roots help in evaluating new strains. A quick-acting machine developed at the Ohio Station for recording the pounds required to pull a plant from the ground makes such determinations. Studies on five prominent hybrids showed a range in breaking strength from 36 to 52 pounds and in pulling resistance from 265 to 377 pounds. Moreover, recent studies of certain inbred lines and crosses strongly indicate that the root strength of a hybrid can be predicted from a knowledge of the root strength of its component lines.

[1]An "inbred line" is a pure-breeding strain of corn having no practical value itself but capable of being combined with other inbred lines into useful hybrids. The crossing of two "inbred lines" produces a "single cross." Most commercial corn hybrids are "double crosses" produced by crossing two "single crosses", and are, therefore, combinations of four "inbred lines."



The relative size and pulling resistance of the root systems of some inbred lines and hybrids of corn

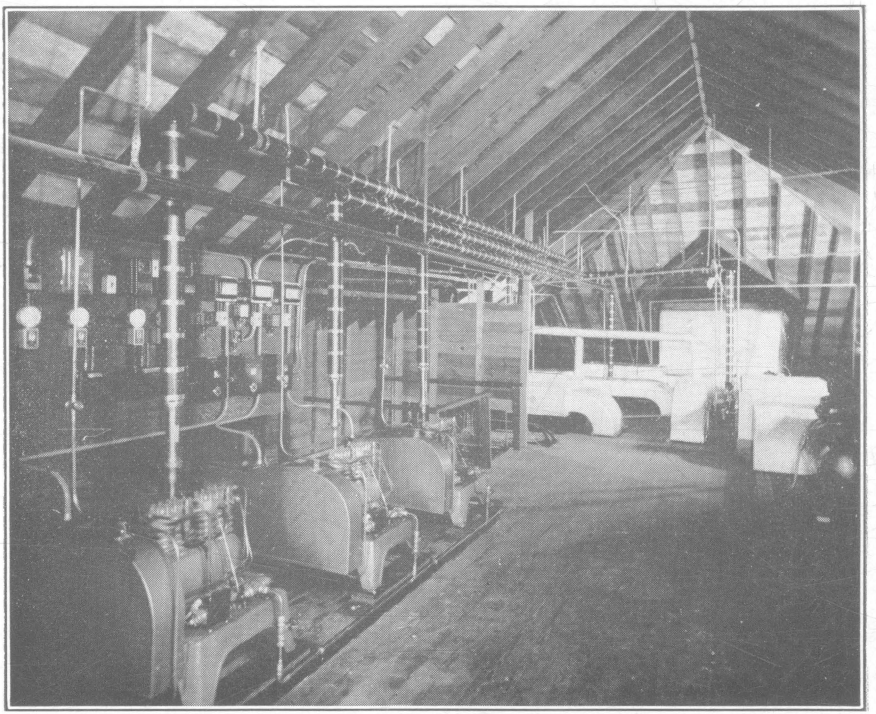
THORNE WHEAT OUTSTANDING IN 1938

Thorne wheat, a new variety just released to growers, turned in an excellent record of performance in 1938. Averaging tests in 13 counties showed 42.1 bushels per acre compared with 37.8 bushels for Trumbull and 36.9 bushels for Fulhio. Thorne is a brown chaff, red kernel, beardless variety originating as a selection from a cross made in 1917 between Portage and Fulcaster. The heads

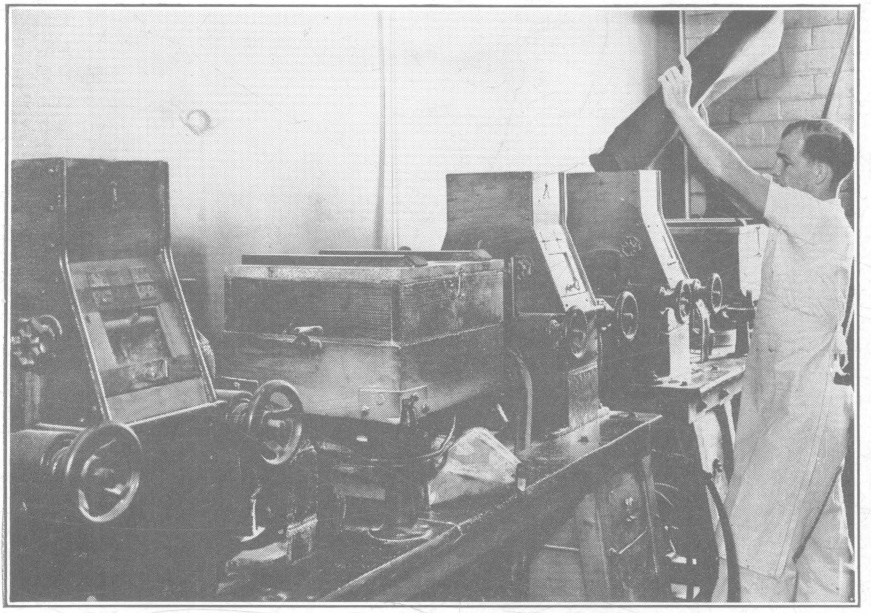
are carried erect on exceptionally stiff straw. Thorne has only slight susceptibility to loose smut and has good resistance to bunt. In winter hardiness it ranks with Trumbull and Fulhio. It is also similar to these varieties in milling quality. Tests show that it is generally adapted over the State. Seed supplies for 1939 sowing will probably be between 10,000 and 20,000 bushels, all certified.

AIR-CONDITIONED MILLING IN NEW WHEAT LABORATORY

The installation of unique equipment for controlling atmospheric conditions during the milling of new wheat varieties at the Federal Soft Wheat Laboratory of the Bureau of Plant Industry, United States Department of Agriculture, located at the Ohio Experiment Station, brings additional safeguards to growers of varieties approved by the Station. The installation is the only one of its kind in the United States and makes possible the milling of wheat under a considerable range of temperature and humidity. These two factors have been shown to play an important part in the milling of high-quality soft wheat flour.



Air-conditioning equipment employed for controlling temperature and humidity in mill room and laboratory of new Federal Soft Wheat Laboratory at the Ohio Agricultural Experiment Station



Part of the equipment used in the experimental milling of soft wheat

LATE SOYBEAN VARIETIES YIELD BEST

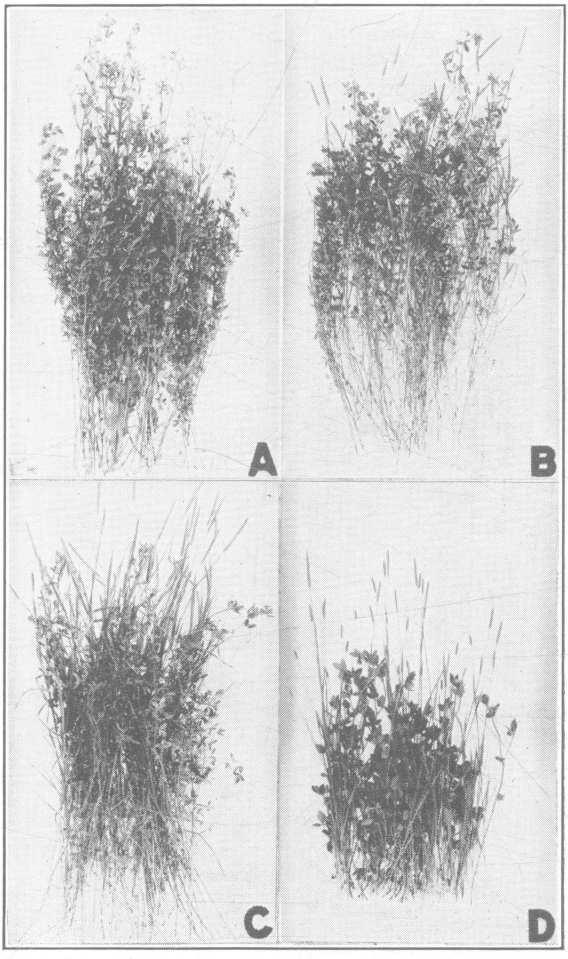
Soybeans are no exception to the rule for main season crops that varieties making use of the full growing season yield best. At least, in tests of six important varieties at four distributed locations, yields have increased with lateness of maturity. Scioto is the latest variety and the highest yielder, Mukden the earliest and lowest yielder. Mandel is second earliest and second lowest in yield. Manchu, Dunfield, and Illini form an intermediate group with respect to both maturity and yield. Breeders are now trying to break the rule by developing a high-yielding early sort that can be combine-harvested ahead of wheat. Success is still problematical.

DISEASE-RESISTANT VARIETIES OF SWEET CLOVER AVAILABLE

Resistant varieties appear to be the only practical remedy for the diseases of sweet clover becoming so prevalent in Ohio and which created so much havoc in sweet clover fields in the spring of 1938. The variety "Evergreen" introduced a few years ago by the Ohio Station is highly resistant but unfortunately a poor seed producer compared with the smaller and earlier maturing sorts. Certified late maturing Kansas sweet clover has equaled Evergreen and was the only commercial sweet clover to show high resistance in 1938.

MIXED ALFALFA-CLOVER-TIMOTHY SEEDINGS RANK HIGH

A good form of crop insurance for hay is the use of an alfalfa-clover-timothy mixture in place of single-crop seedings. Tests in all parts of Ohio continue to show the superiority of alfalfa mixtures to clover-timothy mixtures or pure alfalfa. The alfalfa-clover-timothy mixture has consistently outyielded



Alfalfa mixtures are better than alfalfa alone or clover-timothy mixtures.

Hay from second year of cutting, Columbus, June 13, 1938

A: alfalfa alone, 7 per cent weeds, yield 4,840 pounds
B: alfalfa-timothy, no weeds, yield 5,940 pounds
C: alfalfa-clover-timothy, no weeds, 6,000 pounds
D: clover-timothy, no weeds, yield 3,790 pounds

Note greater height of timothy in alfalfa mixtures.

pure alfalfa at the first cutting in the year after seeding and usually for the year. In 1938, which was more favorable to red clover than to alfalfa, first-cutting yields of mixtures sown in 1937 at Columbus were: alfalfa-clover-timothy, 6,420 pounds; clover-timothy, 6,080 pounds; alfalfa-timothy, 4,280 pounds; pure alfalfa, 2,440 pounds. In favorable alfalfa years alfalfa alone has outyielded clover-timothy but not alfalfa-clover-timothy. Other advantages of alfalfa-grass mixtures over pure alfalfa are greater freedom from weeds and less tendency for winter heaving injury.

RESULTS FAVOR EARLY SOWING OF LEGUMES IN WHEAT

"Better early than late" applies to sowing legumes in wheat. This rule again held true in 1938 in date-of-seeding trials with red clover, sweet clover, and alfalfa at Columbus and Wooster. The best time appears to be March 10 to 20 at both Columbus and Wooster with chances for success better for seedings made before than after these dates. Split seedings, half in early March and half a month later, have been better than full seeding at any single date as a long-time average.

STUDY EFFECTS OF COMBINE ON MEADOW SEEDINGS

Will straw and high stubble left after combine-harvesting of small grains injure stands of alfalfa and clover and reduce the yield of hay? As yet farmers do not seem to agree on the answer to this question. Tests now under way at Wooster should help find the answer, although several years may be required to evaluate seasonal influences. Preliminary results in 1938, following the heavy straw growth of 1937, showed notable improvement in the yield of mixed clover-alfalfa-timothy hay from clipping the tall wheat stubble left after combining. This was true whether the straw was removed or not.

NORTHERN AND SOUTHERN OHIO NEED DIFFERENT CLOVERS

Northern Ohio and southern Ohio are different countries, at least for red clover. High-grade northern Ohio clover seed has failed to give high-grade performance in several years of tests at southern Ohio stations compared with

Northern Ohio red clovers are not adapted to southern Ohio.

Left: northern Ohio medium red clover; Right: Kentucky 101 medium red clover. Southeastern Experiment Farm, Carpenter, April 28, 1938. Both clovers were sown alone in April 1936, cut for hay twice in 1937.

southern Ohio strains, Kentucky 101, and Tennessee anthracnose-resistant red clovers. The southern strains have been both higher yielding and longer lived, chiefly because of their resistance to southern anthracnose and other diseases. Outstanding is the Kentucky 101 strain, now being increased in Ross County. On the other hand, southern strains brought north suffer severely from northern anthracnose in cool damp seasons like May 1938.

FOREIGN CLOVERS FAIL BADLY IN 1938

"Buy at home" is a good slogan for Ohio farmers purchasing red clover seed, according to the results of 1938 hay tests of Central European and Ohio strains at Wooster and Columbus. Hay yields of the first cutting showed European strains averaging 90 per cent as high as Ohio clover at Columbus and only 79 per cent at Wooster. The Ohio clover went ahead and produced good second cuttings, over a ton per acre at both locations, but the foreign strains were so wrecked by leaf hoppers and anthracnose that no satisfactory second cuttings could be made. Moreover, no seed set on the European clovers because of diseased heads. The leaves and stems of native clovers are hairy; those of the European clovers, smooth. It is believed that this characteristic may explain the difference in susceptibility to insects.

Foreign red clovers do not perform well in Ohio.

Left: second-cutting northern Ohio red clover; Right: foxtail following Hungarian red clover destroyed by insects and disease. Columbus, August 14, 1938

"LADINO" PROMISING STRAIN OF WHITE CLOVER

One foreign clover that seems to be making good is Ladino, a giant Italian strain of white clover. In mixture with bluegrass and timothy, it has been pastured two seasons at Wooster by cattle in a rotational grazing system. Periods of grazing for about 3 weeks alternate with similar periods for rest and recovery. Under these conditions Ladino has produced an excellent growth of highly palatable forage throughout the season. Its superiority to native white clover in withstanding the competition of tall-growing grasses makes it promising for seeding in combination with timothy in small grain for pasture after harvest and for 1 or more years following.

YELLOW ALFALFA IS WORK OF LEAF HOPPER

Yellowing of second-crop alfalfa, sometimes of the third crop, was common in Ohio in both 1937 and 1938. This yellowing results from attacks of the potato leafhopper which also stunt the growth of the crop. Dusting every 5 days with pyrethrum-sulfur, although effective in both years, does not as yet appear to be commercially practicable.

Second-crop alfalfa; first crop cut June 10

Left: untreated; Right: dusted with pyrethrum-sulfur mixture every 5 days. August 6, 1938, Columbus

FEED POISON TO INSECTS THROUGH THE PLANT

The agelong quest of scientists for some poison that a plant will absorb through its roots in such amounts as to kill insect enemies without killing itself appears to have been rewarded. At least, aphids and red spiders, ordinarily serious pests of corn grown in certain greenhouse tank culture studies at Wooster, have been effectively controlled by weekly additions of 1 part per million of selenium in the form of sodium selenate to the culture solution, even when the leaves of heavily infested control plants intermingled enough to permit constant migration to the treated plants. Two or three parts per million gave complete immunity to insects without injuring the corn. Unfortunately, higher animals feeding on plants containing selenium are also known to be poisoned. The method is, therefore, unlikely to find practical adaptation with food plants.

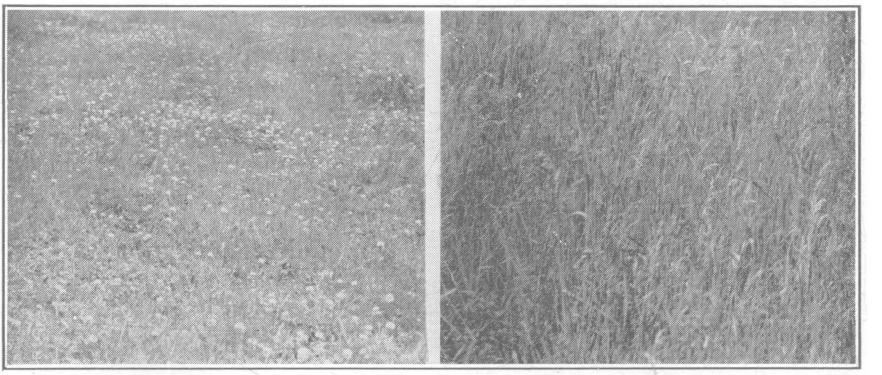
ALL-SEASON GRAZING IS AIM OF NEW EXPERIMENT

Abundant high-quality pasture from early spring to late fall is the goal of experiments under way on the new Armstrong pasture farm at Wooster. Beef steers and dairy cows are used for grazing, and production is measured in terms of meat and milk. Comparisons to date include bluegrass versus orchard grass, both nitrogen fertilized, for early spring pasture; untreated bluegrass – white clover versus the same type of pasture on limed, manured, and fertilized land for main season grazing; second-crop alfalfa-timothy versus timothy aftermath for midsummer grazing. Although the results are preliminary as yet, combining the different crops with rotational grazing has given acre returns in excess of what most farmers would believe possible.

MANAGEMENT DETERMINES CONTENT OF WHITE CLOVER IN PASTURE

Bluegrass pastures enjoy two routes to salvation—the white clover route and the nitrogen fertilizer route. Although the former is generally the more economical, the keeping of a sufficient proportion of white clover in bluegrass pasture is no simple matter. An abundance of lime and phosphate plus plenty

of rain in late summer helps immensely, but grazing management may still make the difference between abundant white clover and none at all. Too light grazing is worse than too heavy grazing; both are bad.



Good pasture management results in good sod.

Left: pasture sod of Kentucky bluegrass and white clover, the product of good treatment plus good management

Right: pasture sod of mature, unpalatable grass with no clover, the result of no clipping and insufficient grazing

Two Columbus pastures, both phosphated in the spring of 1937, have been trial grounds for grazing management procedures. One was grazed more or less regularly and the surplus growth clipped; the other was grazed too lightly and not clipped. By 1938 the first had developed a beautiful white clover – bluegrass sod; the other had lost every trace of clover and consisted only of grass, low both in protein and palatability.

TEST NEW CHEMICAL FOR LAWN WEED CONTROL

Hope springs eternal in the quest for a herbicide that will kill lawn weeds and not lawn grass. A promising new one is "Sinox", real name "dinitro-sodium-naphthanate", tested in 1938 in cooperation with the Crop Protection Institute. One application of a 2 per cent solution killed ground-ivy and heal-all, also yellowed the bluegrass for 2 weeks. Repeated applications of the same strength were required to kill medium-sized dandelions, narrowleaf and broadleaf plantain, and these repeated applications injured bluegrass considerably. A 6 per cent solution in one application killed yarrow and cinquefoil but not sorrel. Two applications of this strength did not completely kill yellow dock. To establish the adaptation and limitations of this new weed killer will require further work.

"TEAR GAS" FOR WEEDS

The hope of finding an effective, economical method, one requiring little equipment, for rendering compost material practically weed free without injury to the physical condition of the soil may soon be realized. In a greenhouse test a tear gas, chloropicrin, killed the seeds of 28 of the 32 weeds most common in turf areas in this region.

BOTANY AND PLANT PATHOLOGY

DEVELOPING NEW SPRAYS FOR FRUIT DISEASES

It has been recognized for several years that lime-sulfur reduced fruit set, gave poor finish to fruit, and frequently caused severe leaf injury. In addition, there has been evidence that leaf stunting resulted from its use. Studies have been planned, therefore, to develop effective fungicides that would be less injurious to foliage and fruit than lime-sulfur or Bordeaux mixture.

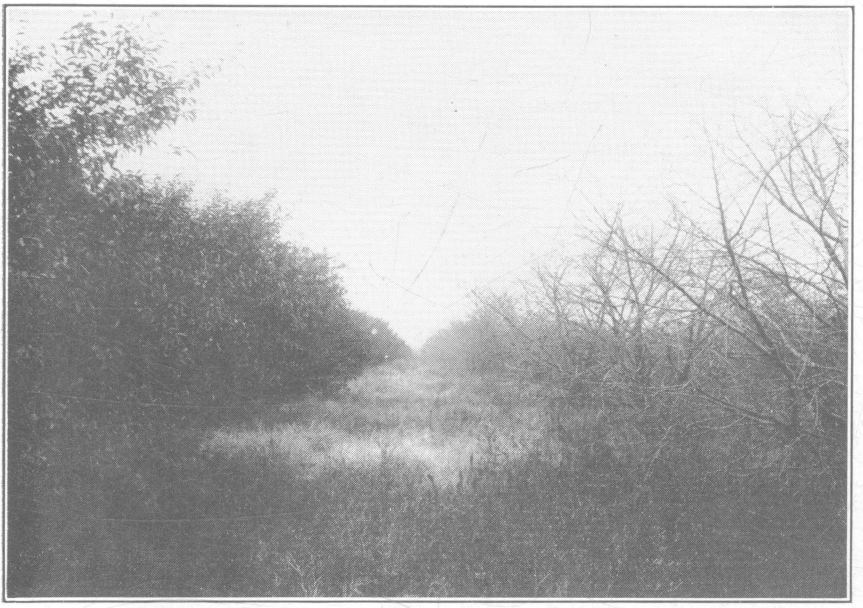
During the seasons of 1937 and 1938, experiments were conducted to determine the amount of leaf stunting resulting from the use of lime-sulfur on apples and sour cherries. The leaves were collected and measured early in July. This early selection of leaves was necessary because later in the season ordinary scorching and edge burning are prevalent and would interfere with accurate measurements. The comparative treatments used on apples were lime-sulfur, flotation sulfur, and no spray (check trees). The data obtained from the measurements of apple leaves showed a 25 per cent reduction in leaf area on the foliage sprayed with lime-sulfur and a 5 per cent reduction on foliage sprayed with flotation sulfur, compared with the checks as standard.

The stunting of leaves sprayed with lime-sulfur, plus the normally visible injury, must be regarded as serious. The losses may not be so great during good growing seasons, but under adverse conditions the fruit set, size, finish, and quality are greatly impaired.

Long before leaf stunting was determined, a definite search for substitutes for lime-sulfur was made. During this period many sulfurs and coppers were tried. Dozens of sulfur combinations, including specially prepared wettables, mostly from ground flour sulfur, various chemical combinations, and the flotation types were tried. Many of the fixed copper compounds were tested; all of them caused too much injury on apples in northern Ohio. The final results of all these tests indicate that only flotation sulfur can be regarded as a substitute for lime-sulfur. In general, the other wettable sulfurs failed to control scab during seasons favorable for its development.

As a result of these studies a new spray schedule for apples is suggested: lime-sulfur in the delayed dormant and prepink, flotation sulfur paste in all subsequent applications. The amount to use is 12 pounds before bloom, 10 pounds at calyx, and 8 pounds in subsequent sprays, in 100 gallons of water. Flotation sulfur paste will also control frogeye, but some form of copper must be substituted to control bitter rot and blotch.

The work with cherry leaf spot control has been very similar to that for apples. Lime-sulfur was the standard spray but was thought to cause leaf stunting. The results obtained from tests during 1937 and 1938 showed that leaf area was reduced as much as 40 per cent by the standard strength lime-sulfur. Moreover, during these same seasons lime-sulfur failed almost completely to control leaf spot. Fortunately, many of the fixed copper compounds tested were effective for leaf spot control and did not cause stunting of the leaves. From these results the new sour cherry spray schedule is as follows: 3 pounds of fixed copper (based on 25 per cent metallic), 3 pounds of hydrated lime, and water to make 100 gallons. Three to four applications are sufficient. The results from limited tests indicate that this same schedule may be used on sweet cherries and plums.



Fixed copper was found to be effective for leaf spot control where lime-sulfur was not.

Left: trees sprayed with fixed copper
Right: trees sprayed with lime-sulfur, defoliated by leaf spot

PROGRESS MADE IN VEGETABLE DISEASE CONTROL

Only in recent years has it become necessary to develop spray or dust schedules for the control of vegetable diseases. Where these new parasites are coming from is a difficult question to answer. It is not difficult, however, to see that they are causing tremendous losses and that regular spraying or dusting practices are necessary.

TOMATO DISEASE CONTROL

Three major diseases are being studied, leaf blights, leaf mold (destructive in greenhouse culture), and wilt. It has been found that most of the leaf blight infection takes place in the field and not in the seedbed. Plants free of disease when set become just as thoroughly diseased in the field under favorable weather conditions as plants containing a trace of leaf spot. It has been found possible to control leaf blights in the field by dusting or spraying thoroughly with a fixed copper compound. The spray formula giving excellent results was 8 pounds of fixed copper (based on 25 per cent metallic), a standard wetting agent used according to manufacturer's recommendation, and 8 pounds of flour, all in 100 gallons of water. The dust formula was 16 pounds of fixed copper (based on 25 per cent metallic), 20 pounds of flour, and talc to make up 100 pounds. The applications should be started when disease threatens and continued at 7- to 10-day intervals.

Considerable progress has been made in the control of tomato leaf mold by the development of the resistant variety called Globelle. The problem was thought solved until new strains of the fungus appeared to which the Globelle was not sufficiently resistant. An attempt is now being made to sort out the common strains of the fungus and, if possible, develop a generally resistant plant. Leaf mold causes severe losses in both the spring and fall crops and no spray program has been effective.

An attempt is also being made to develop varieties of tomato resistant to fusarium wilt. To date only progress can be reported.

VINE CROP DISEASES

A great deal of progress has been made in the control of pickle and melon diseases, especially bacterial wilt. Formerly it was thought only necessary to control the striped cucumber beetle, the carrier of the wilt organism, but the results of more recent experiments indicate that a copper fungicide is highly important. A dust combination developed at the Station and widely adopted in Ohio, as well as other states, is: 12 pounds of fixed copper (based on 25 per cent metallic), 20 pounds of flour, 5 pounds of calcium arsenate, and talc sufficient to make 100 pounds. This dust costs considerably more per pound than the calcium arsenate – gypsum dust, but its advantages more than offset the difference in original cost. These advantages are: It will cover about twice as many vines per pound of dust. It will stick much better, and fewer applications are necessary. It will control wilt better. It will control leaf spots; whereas the calcium arsenate – gypsum gives very little control of these diseases.

Cucumber wilt

The disease sometimes destroys the entire crop.

One serious disease, mosaic, remains uncontrollable at present. It does not respond to fungicidal treatment. Attempts to breed resistant varieties of both pickles and melons are in progress.

OTHER VEGETABLE DISEASES

Other serious vegetable diseases under study are celery blight, celery root rots, blights of carrots, potato diseases, bean diseases, the blight and root rot of ginseng, and the wilt of sweet corn.

Most of the leaf blight diseases can be controlled by a regular dusting or spraying program with Bordeaux mixture or the fixed copper formulas recommended for tomato and vine crop diseases.

The root diseases, such as clubroot of cabbage, celery yellows, the fusarium wilts, and nematode injury, are being studied from two angles, soil disinfection and the breeding of resistant varieties. In greenhouse culture steam sterilization is effective, but it is generally too expensive for field crops. Badly infested fields simply have to be abandoned. This spring a muck field infested with celery yellows and nematodes was treated with a picric acid compound that resulted in an increase in celery yield of over 500 per cent. In other words, a normal crop was grown; whereas the check yielded very little. The cost, however, was too high to be practical. To date the breeding work has produced cabbage resistant to yellows, celery partly resistant to yellows, and tomatoes partially resistant to wilt and leaf mold.

FIXED COPPER SUBSTITUTES FOR BORDEAUX MIXTURE

The fixed or insoluble copper compounds have been developed as substitutes for Bordeaux mixture. In general they cause less injury but are more costly per unit of copper. A large number of them are on the market, and most of them differ in structure and percentage of metallic copper. Consequently, it is impossible to give a standard formula or complete directions for their use. When they are used on fruits, lime should be added at the rate of 1 pound for each pound of copper (based on 25 per cent metallic). Many of the fixed coppers are sold under trade names, but some of the basic compounds are basic copper chloride, basic copper sulfate, copper hydrate, copper silicate, and cuprous oxide.

STUDYING THE BACTERIOPHAGE AS A FACTOR IN THE RESISTANCE TO DISEASE

Transmissible lysins or bacteriophages which check, prevent, or modify bacterial growth are known to be widespread, yet their origin seems to be obscure. These lysins have been detected in decaying organic matter, such as decomposing vegetables, compost piles, manure, septic tanks, diseased plants, and various other sources. Recently it has been found that extracts of viable seeds also commonly contain these lytic substances which affect the growth of bacteria.

In order to establish the probable identity of the lysins in seeds with those isolated from other sources, such as manure, fire blight cankers, and diseased sweet corn, the following lines of comparison were studied: (1) transmission in series with increase in titer; (2) formation of plaques; (3) loss of pigment or increase of viscosity of the test organism in secondary growth; (4) effect of certain organic reagents, such as acetone, alcohol, ether, and chloroform; and (5) adaptation of each respective lysin for other species of bacteria upon which it at first had little or no action.

The close correlation of all lysins in this study leaves little doubt regarding the identity of the lytic factors, regardless of the source from which they were obtained. Further investigation indicates that the lytic factors may arise as a result of an interaction between bacterial parasite and host tissue invaded. If this can be fully established, it will make possible a better understanding of the mechanism of resistance in plants, that is, why some plants are susceptible to disease and others are not.

TEN YEARS OF EVAPORATION AT WOOSTER ANALYZED

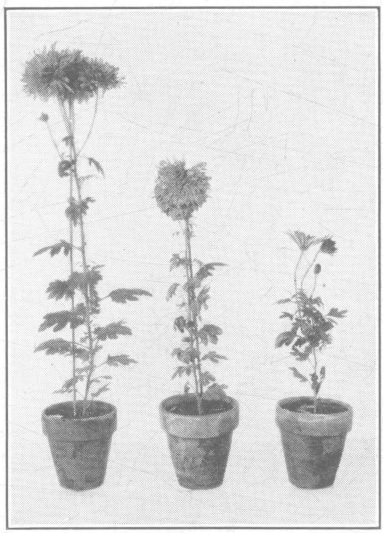
Evaporation from black and white atmometers has been determined daily from May 1 to September 30 for the past 11 years. Ten years of this evaporation data have now been analyzed. Both black and white instruments have been used, so that a measure of the sunlight effect could be obtained, since radiant energy is absorbed by the black and reflected by the white. The period used practically covers the frostless season at Wooster and most of the growing season. Rainfall is commonly thought of as regulating the wetness or dryness of a region or a period, but the rate at which the soil and plants in turn lose this water is also very important in the final moisture economy, as is the rate at which this water is received. Thus, by considering rainfall and evaporation rates together, one gets a much better idea of the dryness or wetness of a season. This is important not only in a study of crop yields but also in making observations on the relationship between moisture conditions of the air and soil and the occurrence and severity of plant diseases.

During the 10 years (1928-1937), there were two severe drouths with evaporation rates about 2.5 times as great as the rainfall, and two others when the evaporation rate exceeded the rainfall rate by 50 per cent. In 1935 the data were reversed, and the rainfall exceeded the evaporation by 40 per cent. The average evaporation was greatest in July and least in September; June, August, and May followed July in that order. July was 40 per cent above September. Radiation (principally sunlight), as measured by the black atmometer, accounted for 29 per cent of the total evaporation and was most effective in June and July. May and August had equal radiations. Radiation was least active in September, and the value in this month was about 30 per cent less than in July. Each hour of sunshine as recorded by the Marvin recorder was represented by about 1.2 cubic centimeters of water loss from the black atmometer. This value was about 1.30 cubic centimeters in July and 1.18 cubic centimeters in May and September.

Many of the relations between evaporation rates and the factors which regulate them have a seasonal periodicity, but this is not true of rainfall. The 10-year evaporation-rainfall average had its lowest value in August, when it was 1.22, followed by June, July, September, and May in that order. It was 1.61 in May. This value was at a maximum in May of 1934, when evaporation exceeded rainfall by 1,600 per cent, and at a minimum in August 1935, when a rainfall of 9.53 inches was 2.4 times as great as the evaporation.

ROGUING AND SELECTION EFFECTIVE IN CONTROL OF VERTICILLIUM WILT OF CHRYSANTHEMUMS

Verticillium wilt is becoming the most widespread and serious disease of cultivated chrysanthemums. Certain excellent varieties, such as compose the Seidowitz group, have lost favor because of extreme susceptibility to verticillium wilt. In fact, the disease is often called the "Seidowitz disease" by growers. The following control measures have been found effective. Since the disease is transmitted through cuttings, only healthy plants should be used for propagation. It is difficult to detect diseased plants of some varieties in the spring when cuttings are taken. The symptoms are most evident in the fall at blossoming time. At this time diseased plants should be rogued out and only healthy, vigorous plants saved for propagation. The number of *Verticillium*-infected plants has been reduced in some varieties from 90 per cent to less than 20 per cent in a single season by carefully roguing the propagating stock. Of 300 varieties tested, 35 per cent were found to be resistant to verticillium wilt.



Verticillium wilt on chrysanthemum; plant on right severely infected

CONTROL OF TREE DISEASES INVOLVES SEVERAL FACTORS

Several hundred specimens from diseased trees are sent in to the Station each year. The control for most tree diseases, except where spraying can be done, involves careful diagnosis and then the use of good cultural practices, thorough sanitation, and roguing out of diseased trees.

The verticillium disease of elms and maples can be fairly well controlled by cultural practices, especially by proper feeding. Careful pruning of diseased parts and then feeding with 10-6-4 fertilizer to build up the vigor of the tree will generally control the disease.

PHLOEM NECROSIS DISEASE OF ELM

Phloem necrosis is probably the most destructive disease of the elm at present, even including the Dutch elm disease. It is killing elms throughout the Ohio River watershed and in many sections has practically eliminated the tree. Its symptoms are flagging, wilting, and phloem discoloration. The disease has recently been diagnosed as being caused by a virus, but there is no definite control measure yet.

ENTOMOLOGY

SOME OHIO CORN GROWERS MUST FIGHT THE SOUTHERN CORN ROOT WORM

In 1937 the root systems of 13 inbred lines of corn were studied at Wooster and Columbus with special reference to damage by the larvae of the Southern corn root worm, *Diabrotica duodecimpunctata* (Fab.).

When the corn was mature, sample plants of each strain were lifted from the ground; the soil was washed from the roots; the root system of each was dried and weighed; and some of the root systems were photographed

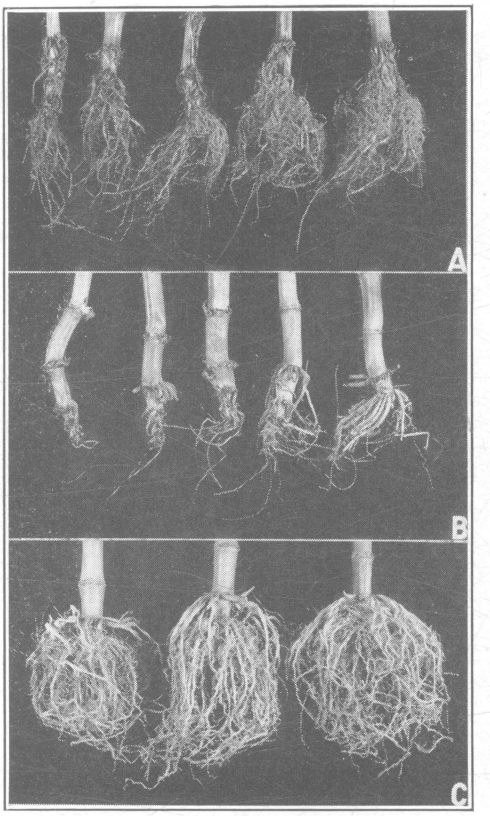
It was found that inbred lines grown at Columbus were much more severely damaged than were the same lines grown at Wooster and that pronounced differences in degree of damage existed among the lines grown in the presence of the severe root worm infestation of the Columbus area. Both of these facts are demonstrated by the root weight records of six strains:

Summary of dry weights (in grams) of roots of different strains of corn grown at Wooster and Columbus, 1937

Strain	Wooster	Columbus	Per cent reduction in weight
Ohio 56	11.7	6.1	48
Ill. 84	10.7	4.6	57
B. P. I. 4-8	20.4	8.5	58
Ind. W. F. 9	26.7	4.5	83
Ill. 90	16.3	2.4	85
Ohio 02	16.8	1.6	90

Attention is directed to the last column of the preceding table, which shows the percentage root-weight reduction of strains grown at Columbus, where root worm damage was severe, as compared with those grown at Wooster, where damage was practically negligible. For example, the roots of Ohio 02 at Columbus weighed 90 per cent less than those of the same strain at Wooster; whereas Ohio 56 at Columbus showed 48 per cent reduction below its weight at Wooster.

The photographic record of two of the strains used in the investigation is no less conclusive than the weight record. It is apparent from the photographic record that few roots remained on the strain Ohio 02 grown in Columbus; whereas the same strain grown at Wooster was damaged but little. If Ohio 56 is compared with Ohio 02, it will be observed that the latter was damaged much more severely than the former when both were grown at Columbus. The superiority of Ohio 56 over Ohio 02 when both were grown under conditions of heavy infestation seems to be due in part to the probability that when the primary roots are damaged the development of laterals is stimulated; differences in seasonal maturity likewise may be a contributing factor.



Representative roots from inbred lines Ohio 02 and Ohio 56

A: Ohio 56 grown at Columbus, 1937
B: Ohio 02 grown at Columbus, 1937
C: Ohio 02 grown at Wooster, 1937

ORIENTAL FRUIT MOTH YIELDING TO PARASITES

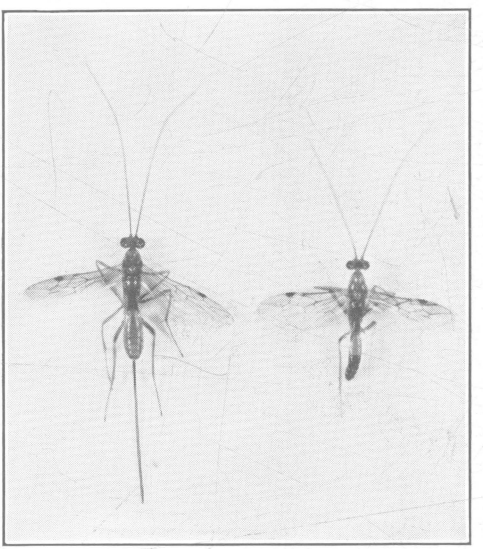
The 1938 infestation of Oriental fruit moth, *Grapholitha molesta* Busck, was one of the lowest on record since this insect became a pest in Ohio. The diminishing degree of damage to fruit is apparently due chiefly to the activity of larval parasites.

Twig-feeding fruit moth larvae collected in 1938 from various orchards in the State were heavily parasitized. Several collections obtained during June and July showed at least 90 per cent destroyed by parasites. This may have been due in part to the mild winter of 1937-1938, which probably permitted greater numbers of parasites to hibernate successfully. However, more larval parasites were released during the 1938 season than in any previous year. One

hundred and two parasite colonies containing approximately 19,000 parasites representing four different species were released in 76 places in 25 Ohio counties.

Many parasites were obtained from the Federal Parasite Laboratory at Moorestown, New Jersey, through a cooperative fruit moth project; others were reared in the laboratory at Wooster.

Macrocentrus ancylivorus Roh. is the most effective fruit moth parasite now found in Ohio.



The most effective Oriental fruit moth parasite in Ohio, *Macrocentrus ancylivorus* Roh.

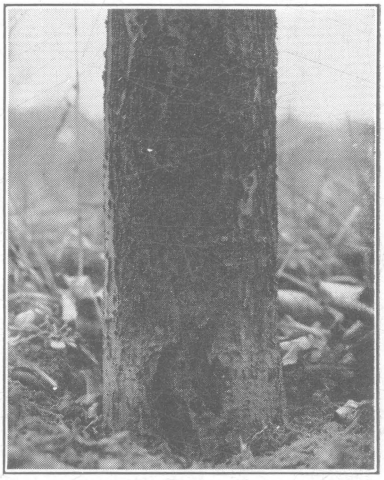
Female on the left, male on the right

SEEK TO CONTROL ROUND-HEADED APPLE-TREE BORER

Ohio orchardists have been fortunate in that attacks of the round-headed apple-tree borer, *Saperda candida*, have been mostly local in character. This is due to the erratic distribution in the State of the wild hosts, of which serviceberry and wild crab apple support the greatest number of borers. Old or neglected orchards also furnish breeding places for borers, and it is in the neighborhood of such orchards or wild hosts that damage is likely to be most severe. Young apple trees planted near such sources of infestation must be watched carefully and guarded against attack until they are at least 12 years of age.

The adult borer is a large gray-and-white beetle which emerges from the trunks of apple trees during late May and throughout June and lives for several months. During June, July, and August the females place their eggs in slits in the bark at the base of the tree; occasionally they deposit them in the crotches. The eggs hatch in from 2 to 3 weeks and the young borers start feeding at once.

The problem of control would be solved by any economical method that would prevent egglaying. All experiments to date in Ohio have been made with this in mind. In publications dealing with this insect, wrapping the base of the tree with paper or cloth is usually advised, but little has been said about the kind of paper or cloth to use or how to wrap it. Part of the experimental program, therefore, has dealt with the use of different materials, such as newspaper, crepe paper in sheets and strips, heavy waxed paper, and burlap in sheets and strips. In addition, several tree paints, paraffin emulsions, plastic waxes, tanglefoot preparations, and latex emulsions have been painted about the bases of trees to try to prevent egg deposition. Several of the tree paints were combined with toxic materials, such as lead arsenate and fluorine compounds. All treated trees were mounded with earth so that no uncovered areas of bark remained at the base.



Borer injury at the base of a mounded tree

The borers have been cut out and all dead bark has been removed to facilitate healing. The top of the mound approximated the top of the wounds.

At the end of 4 years of work, the results may be summarized. All paints, waxes, emulsions, and tanglefoot preparations, whether used alone or reinforced with toxic materials, were ineffective in the control of the borer. The sticky tanglefoot preparations were also injurious to the bark of the trees. All wraps of cloth and paper prevented egglaying and borer damage. Newspapers, folded once and wrapped twice about the trunk, were as effective as any of the materials.

Among the older recommendations for control was mounding the tree with clean earth so that egg deposition would be higher on the trunk and the resulting borers easier to cut out. For orchards with less than 20 per cent of the trees infested this is still the most practical remedy. With heavier infestations it is practical to wrap the trees. No more labor is involved in applying and removing the wraps than in cutting out the borers. Moreover, the wrapped trees escape borer damage.

LEAFHOPPER CONTROL BRINGS 71 PER CENT MORE POTATOES

Of the numerous materials tested during the past 5 years, Bordeaux mixture has given the best and most consistent control of the potato leafhopper (*Empoasca fabae* Harris). Plants properly sprayed with Bordeaux mixture did not show the dwarfed, curled, brown foliage characteristic of untreated plants affected with hopperburn. The leafhopper population of the sprayed plants was only 9 per cent of that on the unsprayed plants. Bordeaux-sprayed plots showed an average yield of 387 bushels per acre during the 5-year period;

unsprayed plots an average of 226 bushels per acre. The difference, 161 bushels, represented an increase in yield of 71 per cent due to the control by Bordeaux mixture.

Experiments indicate that reducing the lime content to one-half that of the copper increases the efficiency of Bordeaux mixture. A 5-2½-50 mixture showed a slight advantage over a 5-7½-50 Bordeaux 3 out of 4 years. The decrease in lime content also reduces the wear on the pump parts, the cost of spray material, and the cost of the spraying operation.

Dusting with freshly mixed 20-80 copper-lime dust produced results as satisfactory as spraying with Bordeaux mixture. The dusting, however, must be done at a time when the plants are wet with dew and, if necessary, the application should be delayed until conditions are favorable. It is, therefore, often difficult, if not impossible, to do a satisfactory job of dusting on a commercial scale.

Fine dusting sulfur gave excellent control of the leafhopper but the yield of tubers was slightly lower than following the use of Bordeaux mixture. A number of insoluble copper compounds were tested; some of them appear promising. These materials, however, are in the experimental stage and at present do not appear to have any advantage over Bordeaux mixture.

Experiments designed to determine the proper timing of sprays indicate that spraying operations should begin as soon as the plants are well above ground, and before injury is apparent. Failure to apply the first two sprays on time has brought a 22 per cent decrease in yield. The first four applications should be made at weekly intervals to provide maximum protection to the foliage. Growth of the young plant is exceedingly rapid and new tissue is constantly being added in the form of new leaves and stems, and in the increased size of the older plant parts. After the middle of the growing period, when growth is much less rapid, the interval between sprays may be safely lengthened to 10 to 14 days.

The spray mixture must be applied in sufficient quantity and in a way that will cover the foliage thoroughly. Unless the grower gives spraying his careful attention, he cannot expect maximum benefits from it.

DUSTS EVALUATED FOR CABBAGE WORM CONTROL

In 1938, 19 different dust treatments were evaluated for control of the cabbage worms, *Ascia rapae* (Linn.), *Autographa brassicae* (Riley), and *Plutella maculipennis* Curtis. Paris green, derris powder, and insecticides prepared from pyrethrum were combined with various diluents and adherents. Lead arsenate, zinc arsenite, and pyrethrum powder were diluted with talc.

The gross weights of cabbage produced by plots receiving the several treatments were very similar, but when the worm damage was trimmed off, significant differences were observed. The largest yields of merchantable cabbage were produced by plots dusted with Paris green. The plots treated with lead arsenate, derris powder, pyrethrum, and zinc arsenite followed in descending order. The untreated check plots yielded approximately one-half as much as the plots dusted with Paris green.

At harvest time only 4 per cent of the heads from the untreated plots were entirely free from worm damage; whereas 67 per cent of all heads from the

plots dusted with Paris green were free from such injury. The plots treated with lead arsenate produced 64 per cent, derris powder 23 per cent, zinc arsenite 8 per cent, and pyrethrum extracts and powder 6 per cent of damage-free heads.

The effect of the use of Paris green in cabbage worm control

Left: received no treatment
Right: received four Paris green dustings

Chemical analysis showed that cabbage cut to U. S. No. 1 grade carried a negligible amount of arsenical residue. When the cabbage was cut 20 days after the last dust application, practically all of the arsenic which remained was on the four wrapper leaves.

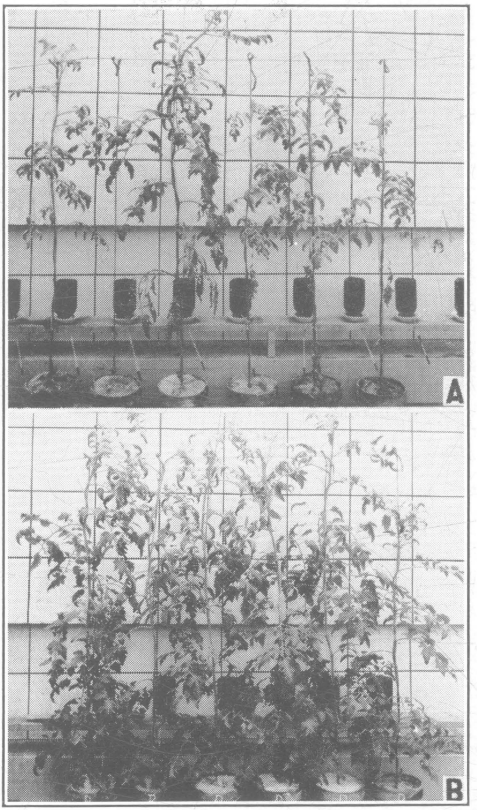
INSECT POISON SUPPLIED TO PLANTS THROUGH ROOTS

Through many years of study on methods of insect control, scientists have sought a poisonous substance that plants will take up through their roots. Work done at Washington, D. C., by Hurd-Karrer and Poos demonstrated that wheat plants took up selenium from nutrient solutions and stored it in their tissues. This work showed also that plant lice failed to thrive on plants that had received as little as 3 parts per million of selenium. When the plants received as little as 1 part per million, the plant lice were checked but some reproduction took place.

In an experiment started at the Ohio Experiment Station, November 1937, the common greenhouse red spider, *Tetranychus telarius* L., was used as the test animal, tomato as the host plant, and selenium as the poison. The plants were grown in 10-inch pots filled with pure sand which was kept saturated with the nutrient solution. Thirty plants, divided into five lots of six plants each, were used in the test. The six plants in treatment A received the nutrient solution only. Those in treatment B received the same nutrient solution, to which was added selenium at the rate of ½ part per million in the form of

sodium selenate. Those in treatments C, D, and E likewise received the standard nutrient solution, to which were added 1, 1½, and 2 parts per million of selenium, respectively.

The addition of the selenium to the nutrient solution was withheld for a few days until November 10, 1937, in order to allow the plants to become established. Three days later approximately equal numbers of red spiders were placed on all plants.



Selenium solution controls red spider

A: check plants. No selenium added to nutrient solution

B: plants grown in nutrient solution to which selenium was added at the rate of 1½ parts per million

The effect of the several treatments on red spider was determined January 4, 1938. On that date two sample leaves were taken at random from each plant, one at mid-height and one near the top, and the red spiders counted on each leaf with the aid of a binocular microscope. The average infestation of the samples taken from the six plants in lot A, which had not received selenium,

was 167 spiders, treatment B (selenium ½ p. p. m.) 53 spiders, treatment C (selenium 1 p. p. m.) 6 spiders, treatment D (selenium 1½ p. p. m.) less than 1 spider, and treatment E (selenium 2 p. p. m.) also less than 1 spider.

The experiment was completed on January 24, 1938. At that time the plants in treatment A, which had not received selenium in the nutrient solution, were almost dead from red spider injury. Those in treatment E were undersized because of the toxic effect of too much selenium. The plants in treatments B, C, and D appeared normal.

The results secured in this experiment are encouraging. It should be clearly understood, however, that this method of pest control is being investigated for ultimate use on ornamental plants only. Selenium is too poisonous a material to be used on plants grown for food. Tomato was used in this investigation because plants were readily available and because tomato is highly susceptible to red spider attack. The project has been expanded to include other species of both plants and insects.

STUDYING THE USE OF LIGHTS IN TOMATO PEST CONTROL

The response to lights of three tomato pests was studied at Marietta, Ohio, in 1938. These insects were the tomato fruit worm, *Heliothis obsoleta* Fab., the army worm, *Cirphis unipunctata* (How.), and the tomato worm, *Protoparce sexta* Johan.

In order to obtain a wide range in light intensity as well as in light quality for the experimental setup, the following lights were used: 60-watt CX lamp, 15-watt blue fluorescent lumiline lamp, Type H-4 mercury vapor lamp, Type S-4 mercury vapor lamp, and two Mazda lamps, 100 watt and 150 watt. A moth-capturing device was used in connection with each light.

Concerning the tomato fruit worm, it may be said that the light captures revealed a sparse population in June and a gradual increase during the season. Two to five moths were captured nightly in June and as many as 30 per night in August. From June to September 12, 22 moths came to the 100-watt and 150-watt Mazda lamps, 35 to the blue fluorescent, 97 to the H-4, and 131 to the S-4 lamp.

Over a 2-month period, 136 army worm moths were captured at the blue fluorescent lamp, 516 at the Type H-4 mercury vapor, and 731 at the Type S-4 mercury vapor.

The tomato worm responded as follows during a period of 2 months. Three were captured at the blue fluorescent lamp, 82 at the Type H-4 mercury vapor, and 192 at the Type S-4 mercury vapor lamp.

It is hoped that eventually artificial light may be made to serve a useful purpose in tomato pest control, particularly of the tomato fruit worm. There is a possibility that in the future, light data may be used in properly timing dust or spray applications for this insect or that lights of sufficient potency may be found that will either attract or repel the insects to such a degree that the use of sprays or dusts will not be needed.

MODIFIED TWO-QUEEN SYSTEM FOR HONEY PRODUCTION TRIED

A modification of the standard two-queen system in the management of bee colonies for honey production in Ohio was attempted this past season. The standard two-queen system makes use of two queens previous to and throughout the harvest period. The modified two-queen system utilizes two queens in a colony during the spring building-up period and through the first week of the clover flow, at which time the colony is reduced to the single-queen system. The modified two-queen method ensures an enormous adult bee population at the beginning of the major honey flow, adequate reserve strength in the form of brood, and the requeening of the colony—all primary factors in obtaining maximum honey production.

Comparative tests in honey production were made between colonies managed by the single-queen system and colonies managed by the modified two-queen system. The 10 colonies used in the single-queen series averaged 150 pounds of surplus clover honey. An approximate average yield of 240 pounds was harvested from the 10 colonies managed by the modified two-queen system.

Comparative tests on this proposed system will be continued several years so that safe recommendations on the new system may be given to Ohio honey producers.

HORTICULTURE

SYNTHETIC GROWTH SUBSTANCES AID IN ROOTING CUTTINGS OF ORNAMENTAL PLANTS

The use of synthetic growth substances as an aid in rooting cuttings of many greenhouse plants has resulted in a decrease of the time required for root production and an increase in the number of roots produced. Dusts of several of these growth substances have also been used with success. In using them the basal end of the cutting was stirred in the dust until the stem was thoroughly covered. Then the cutting was lightly tapped to remove the excess dust and placed immediately in the propagating medium. The chief advantage of the dusts lies in their ease of application. Their chief disadvantage is that if a relatively high concentration is required, it is almost impossible to obtain it.

The results of the use of the synthetic growth substances on cuttings of woody ornamental plants can be summarized as follows:

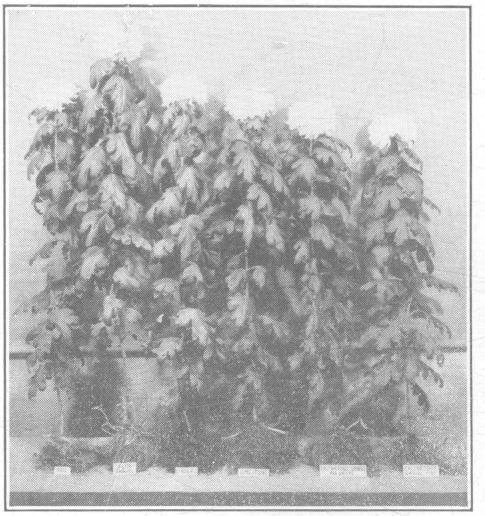
1. Hardwood cuttings responded less, when they responded at all, than softwood cuttings.
2. Plants normally easily propagated by cuttings were easily stimulated by the use of synthetic substances at optimum concentrations.
3. Plants normally difficult to propagate by cuttings (*Hydrangea petiolaris, Juniperus virginiana cannarti*) were difficult even when growth substances were used. Only one plant, *Cornus florida rubra*, was found to be an exception.
4. The treatment of cuttings with growth substances did not significantly change the position of the roots on the stem.
5. The use of growth substances on narrowleaf evergreens resulted in higher percentages of rooting when optimum concentrations were used. The concentrations required decreased as the cuttings passed through their rest period. While cuttings were in deep rest, the greater the number of roots that developed, the shorter their length. This is not always true of cuttings after their rest. Evidently factors other than the food within the cuttings enter into the picture.

FLOWERS GROWN ON GRAVEL OR CINDERS WITH NUTRIENT SOLUTION

Roses, chrysanthemums, carnations, stocks, sweet peas, irises, calendulas, marigolds, pansies, annual chrysanthemums, and centaureas have been successfully grown on gravel and cinders subirrigated with nutrient solutions. The essential features of the system are a waterproof bench, a tank underneath containing nutrient solution, and a pump and motor operated automatically by a time clock. Various solutions and media have been tested.

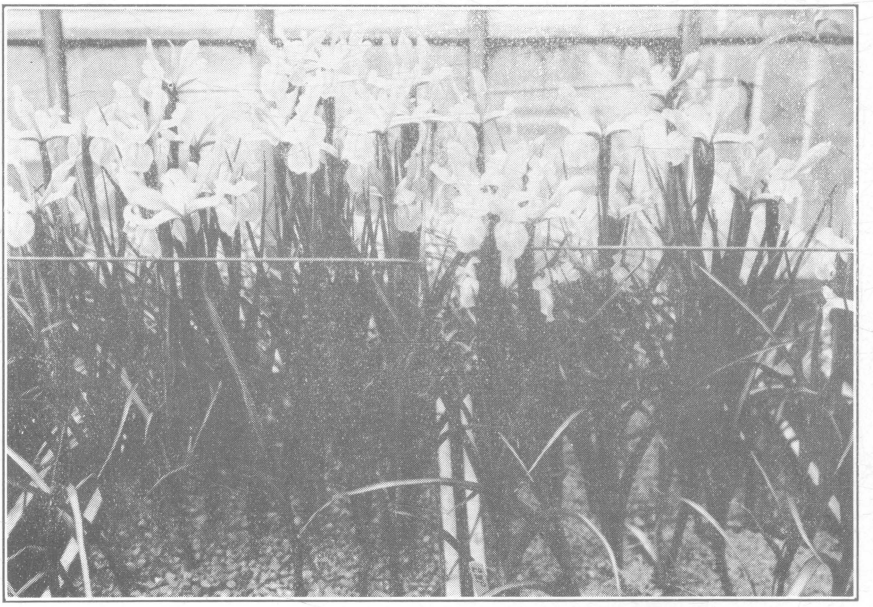
The production of roses from July 15 to October 15, 1938, was as follows:

	Flowers per plant
On soil plot	10
On gravel plot	16
On cinder plot	19



Chrysanthemums from various nutrient solution beds compared with plant grown in ordinary soil

From left to right: soil, silica gravel, cinders, limestone, pea grade calcareous gravel, fine calcareous gravel



Wedgewood (bulbous) iris grows successfully in gravel and cinder culture.

PLANTS SHOW DEFICIENCY OF MINOR ELEMENTS

A number of greenhouse floricultural crops were grown in sand with nutrient solutions deficient in boron, calcium, iron, magnesium, manganese, and sulfur, and the general symptoms of deficiency were noted.

Boron deficiency caused dying of the terminal bud. The upper leaves became thick and brittle.

Calcium deficiency resulted in the death, first of the feeding roots, then of the terminal bud, and finally of the entire plant.

Iron deficiency produced a chlorosis of the leaves. In severe cases dead areas appeared at the tips and margins of the yellowed leaves.

Magnesium deficiency reduced the rate of growth. The lower leaves turned yellow between the veins. At times dead spots appeared suddenly on these leaves. In some plants the leaves puckered.

Manganese deficiency caused the top leaves to turn yellow between the veins, but even the minute veins remained green. Sometimes dead areas developed in the middle of the leaves.

Sulfur deficiency made the veins of the upper leaves turn light in color.

STUDY FLOWERS IN A CLOTH HOUSE

The use of additional light on asters in the seedling stage resulted in earlier flower production. Seeds were sown March 9 and lighted from 6 p. m. to 10 p. m. with 40- and 60-watt bulbs from March 31 to May 1. As a result of this additional light most of the crop was ready to cut in July.

A number of tests were carried on with pompon chrysanthemums. Tests with various mulches showed no increase in yield from mulching with either glass wool, German peat, or huminal peat. Reducing day length by shading resulted in earlier flower production on pompon chrysanthemums; as a general rule flowers could be expected 8 weeks from the time of shading. Stem length and date of flowering were proportional to the amount of light penetrating the cloth; the greater the light penetration, the longer the stems and the later the flowering. As previously observed, pinching the variety Nellie Kleris 1 week before shading gave satisfactory flower production.

Gardenias, azaleas, and buddleias were grown in the cloth house and growth was better than in either a lath house or greenhouse.

Tests with own-root and grafted (Manetti) Better Times roses showed that own-root roses gave better growth than grafted stocks. It is entirely possible that own-root roses may be grown in a cloth house 1 year prior to planting in the greenhouse in winter.

STEAM STERILIZATION OF GREENHOUSE SOIL INCREASES FLOWER CROPS

The tile method of steam-sterilizing greenhouse soil in raised benches has resulted in increased production of flower crops. Crops grown in soil sterilized by this method have outyielded those grown in field soil and unsteamed greenhouse soil.

Weekly tests for ammonia, nitrites, nitrates, and soluble salts showed that chemical changes in the soil were not due directly to steaming but were a result chiefly of the activity of microorganisms.

Nitrites were present in leached plots for 5 to 6 weeks and in unleached plots 2 to 3 weeks. Ammonia was present within 1 week after steaming and reached a peak in 3 to 5 weeks. It then decreased, and after 6 to 8 weeks was absent. Nitrates decreased 1 to 2 weeks after treatment, then increased as the ammonia decreased. The peak in nitrates was reached in 4 to 6 weeks; then there was a decrease.

Soluble salts increased as the nitrates increased and began a slight decline as the nitrates declined. Leaching after planting was ineffective in removing a large amount of soluble salts, even though water was applied at the rate of 5 gallons per square foot of soil.

Counts of bacteria, molds, and actinomyces were made in soils steamed from ½ hour to 6 hours. The bacteria and molds killed were directly proportional to the length of time the soil was steamed. Actinomyces were apparently rendered inactive by treatments of a half hour or longer.

Within 1 week the bacteria were far more numerous in the steamed soil than in the unsteamed. In treatments of 2 hours or less they remained so for 17 weeks or longer. In treatments of 4 and 6 hours the numbers of bacteria were less after 10 or 11 weeks than in the unsteamed soil. Similar results were obtained with molds.

In treatments of 1 hour and less the numbers of actinomyces did not approach those in the unsteamed soil until 15 weeks after steaming. Thereafter they were comparable. Treatments of 4 and 6 hours were comparable to the unsteamed soil after 5 to 8 weeks.

ARTIFICIAL DROUTH DOES NOT REDUCE SIZE OF APPLES

It would be expected that a complete lack of rainfall from May 1 until harvest would produce an extreme reduction in the size of fruit in an apple orchard. Contrary to such expectation, Stayman Winesap trees in the Station orchard have withstood the third season of severe water shortage without producing fruits smaller than those on trees receiving abundant water.

To produce this artificial drouth, all rainfall was diverted by special canvases which covered the surface of the soil around the tree to a radius of 20 feet. Galvanized iron sheets sunk into the ground just within the outer edge of the canvas to a depth of 2½ to 5 feet prevented the lateral movement of water to a corresponding depth. The moisture was gradually withdrawn from the soil by the tree roots, and measurements were taken of the growth of the fruits weekly. At the same time soil moisture determinations were made at four separate locations to a depth of 4 feet.

There are three main reasons for the lack of detrimental symptoms under these conditions. The first of these is the soil type. The supply of water held by Wooster silt loam, the type in which the trees were growing, is large and readily available. This soil has a field capacity of 23 per cent, and the permanent wilting percentage is 8 per cent. The difference between these two values, 15 per cent, is called the available water and is equivalent in this soil to 10 acre-inches of water to a depth of 4 feet. This represents a reservoir equivalent to at least 2 months of average rainfall at Wooster. Furthermore, the water is apparently removed for utilization by the tree without undue resistance from the soil, within the range of soil moisture extending from the field capacity to the permanent wilting percentage.

In the second place, the reaction of the stomates themselves is an important factor. Their opening and closing regulates to a large degree the rate of water loss from the leaves. In this experiment they were found to open later in the forenoon and close earlier on the trees without rainfall than on those under favorable water conditions. In fact, they began to close earlier in August—2 months before the fruits were harvested. This reaction was an important factor in increasing water conservation of the trees without rainfall.

In the third place, according to excavations completed in the fall of 1938, the tree roots penetrated to a depth of 9 or 10 feet, even though a far greater proportion of roots was in the upper 3 feet. Obviously under these circumstances considerably more water is available than in the case of shallow-rooted trees.

This work is of importance directly as a study of the efficacy of irrigation in the Wooster silt loam and indirectly as an emphasis upon the value of soils which permit deep rooting, and whose other attributes are favorable for orchards.

DETERMINE PICKING DATES FOR RED STRAINS OF APPLES

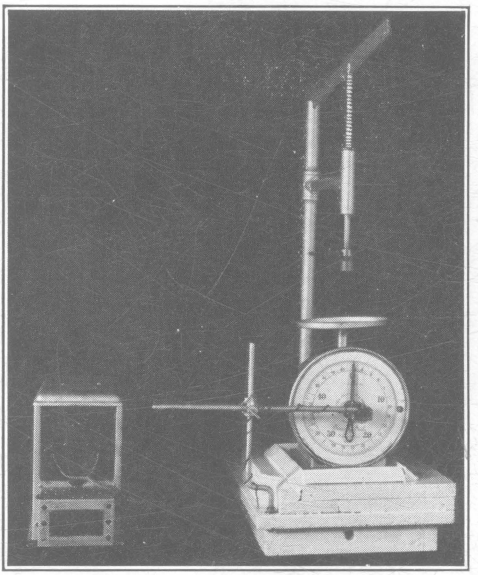
An earlier harvesting date has been one of the advantages claimed for many of the red strains of apples introduced in recent years. Tests made at the Experiment Station show that red strains should be harvested at the same time as the parent standard varieties of apples.

Richared and Starking are red strains of Delicious. In 1937 liberal samples of these varieties were picked at weekly intervals on September 27, October 4, and October 11. At Wooster the time recommended for beginning the Delicious harvest was approximately October 4. The apples were stored as soon as harvested in a blower type refrigerated storage, and observations of the storage samples were made at monthly intervals. The following indexes of maturity and condition were used in comparing the samples picked on different dates: pressure tests, acid and sugar analyses, and dessert quality. Dessert quality ratings were made by securing the composite judgment of members of the Department of Horticulture. Although Richared and Starking were well colored at the first picking, the mechanical, chemical, and flavor tests showed that these varieties did not reach proper maturity until Delicious was of proper maturity for harvesting.

Rome Beauty and the red strain, Gallia Beauty, were harvested in a similar manner except that four pickings instead of three were made. Here the results indicated that even though Gallia Beauty attained a high degree of coloring much earlier than Rome Beauty, the optimum picking dates for the two were essentially the same.

APPLES RIPEN AT DIFFERENT RATES IN DIFFERENT TYPES OF STORAGES

In connection with the storage studies on apples, the rate of ripening, or softening, has been determined at frequent intervals by means of an improved "pressure tester." To measure the hardness of an apple the fruit is placed on the scale platform, and the lever is pulled down to force the plunger into the tissue. When the plunger has penetrated a fixed distance, an electrical circuit is automatically closed so that the pointer is held by the magnet for an exact reading of the pressure.



"Pressure tester" used to determine rate of ripening of fruits in storage

An electromagnet supported on the crossarm is an improvement recently developed to ensure accurate reading of the pointer at the instant the plunger penetrates the fruit tissue to a fixed distance.

Apples placed in refrigerated storages were at nearly the same stage of ripeness at the end of the fifth month as those in common storage at the end of the second month. For example, the average of pressure readings on several apple varieties was 12.41 pounds at the end of 2 months in common storage and 11.87 pounds at the end of 5 months in refrigerated storage.

The pressure determinations for the entire storage season showed that in two types of refrigerated storages (forced air and conventional pipe coil) the pressures averaged 13.2 and 13.3 pounds, respectively.

The improved pressure tester also revealed that in unrefrigerated storages the apples ripened most rapidly during the first month; whereas in refrigerated storages the rate of ripening was most rapid during the second month.

CIDER PRESERVED BY CARBONATION

Cider clarified by filtration through cotton in a Karl Kiefer filter was kept for 3 months at room temperatures under 100 to 125 pounds of pressure of carbon dioxide. At the end of the test the cider was found to be free from live bacteria, yeasts, and molds. It had a slight cooked taste, although the temperature in the room was only about 75° F. The carbon dioxide taste was barely noticeable.

Cider condensed to 26 per cent sugar by centrifuging frozen cider was carbonated at 3½ volumes. All samples kept without spoilage for 1 year. Five ounces of the 26 per cent concentrate in a 12-ounce bottle produced the most desirable flavor.

Attempts to preserve cider in bottles by carbon dioxide generated within the bottles resulted in failures.

TWO NEW BERRIES RECOMMENDED FOR THE HOME GARDEN

Two new cane fruits, the Boysenberry or Boysen dewberry and the Indian Summer raspberry, have recently been introduced into Ohio. Both may find a place in home gardens, but seem unlikely to prove of value to the large commercial grower.

A fruiting cane of the Indian Summer red raspberry, an autumn-bearing variety Photographed October 18, 1938

The Boysenberry or Boysen dewberry has received wide publicity. It has, however, two disadvantages. The canes need to be supported on a wire trellis, and the vines are killed by severe winters. To ensure a crop, the canes must be protected during the winter by a covering of soil or a mulch of straw or other material. The berries are of high quality, of distinctive dark red color, and are especially good for canning. They ripen over a long period. Compared with raspberries and blackberries, the yield has not been outstanding in tests at Wooster.

The Indian Summer is a very superior autumn-fruiting raspberry from the New York Experiment Station and was introduced in 1936. Its berries are rather soft and crumble easily; otherwise it would probably be a valuable commercial raspberry. Limited tests at the Ohio Experiment Station suggest that it may be a valuable addition to the home garden. Observations indicate that the plants are vigorous and hardy. The berries are more similar to the June-bearing types, both in size and quality, than to other "everbearers." A small crop is borne in June, but the major crop ripens during October. The Indian Summer will not replace the standard June-bearing red raspberries, but it is a valuable addition to the raspberry group.

TOMATO AND CABBAGE VARIETIES TESTED

Among 21 varieties and strains of tomatoes tested at Marietta, Pritchard from the Associated Seed Growers ranked first; Penn State from Holmes ranked second; Scarlet Dawn from Associated Seed Growers ranked third; Valiant from Stokes ranked fourth; and Scarlet Dawn from Holmes ranked fifth.

Forty-six varieties and strains of cabbage were tested at Columbus. The ranking of varieties was based largely on relative earliness, and first rank was given to early varieties. Golden Acre No. 5 from Suhr ranked first; Yellows Resistant Golden Acre 37091 from Hansen ranked second; Ohio Agricultural Experiment Station Resistant No. 5 ranked third; Early Wonder from Sluis en Groot ranked fourth; and Yellows Resistant Golden Acre from Holmes ranked fifth. The heaviest yield was produced by All Head Select from the National Kraut Packers Association. Following closely was Wisconsin All Seasons Yellows Resistant from Ferry-Morse.

TOMATO LEAF SPOT CONTROLLED IN HOTBEDS BY ADEQUATE VENTILATION

Indiana Baltimore tomato plants were grown in hotbeds with and without adequate ventilation. Special attention was given to the heating and ventilating at night and during cloudy days. Even where plants were artificially inoculated with *Septoria* and *Alternaria*, the diseases were kept in check by adequate ventilation, irrespective of whether the hotbeds were heated by hot water, steam, electricity, or manure.

In the poorly ventilated hotbeds the artificially inoculated plants were immediately infected and stunted. Later the uninoculated plants with poor ventilation became infected. Finally in all the hotbeds, when the plants became so large and crowded that it was impossible to keep the foliage dry, some of the leaves became infected.

Healthy plants from the uninoculated, well-ventilated beds set out in gardens produced at the rate of 14 to 17 tons per acre. Diseased plants from the inoculated, poorly ventilated beds produced 5 tons per acre.

VARIETAL, CULTURAL, HARVESTING, AND STORAGE CONDITIONS AFFECT VITAMIN C CONTENT AND ACIDITY OF TOMATOES

Much attention has been given recently to the value of the tomato as a source of organic acids and vitamin C in the diet. To determine more definitely the differences between varieties in vitamin C and acidity and the effects of various cultural, harvesting, and storage conditions upon synthesizing and

maintaining the original potency of these substances, 70 sorts were raised in the field under uniform conditions. Two varieties were raised in the greenhouse under various cultural conditions to supplement the field trials.

The field tests included representative types of all sizes, colors, and culinary uses. The analyses were made on vine-ripened fruits except where otherwise stated. The juices were extracted by a mechanical press. Vitamin C and total acidity were determined by titration and the pH values by the potentiometric method. Vitamin C, in the juice thus obtained, varied from 0.381 milligram per cubic centimeter down to 0.151 milligram per cubic centimeter. The mean average of all varieties was 0.262 milligram per cubic centimeter. Neither size nor color of the fruit is correlated with vitamin C potency.

The acidity and pH of the juice varied widely with the variety and were not very definitely correlated with color or size of the fruits. There was a correlation between total acidity and vitamin C. In general, the more acid tomatoes were higher in the vitamin, but the most acid fruits were not necessarily the highest.

In addition, ripe fruits from several varieties were analyzed at intervals throughout the season. No tendency was found for vitamin C, pH, and acidity to change much. Apparently with healthy plants there is no distinct change in the character of the fruits in these qualities as the season advances.

RIPENING TOMATOES UNDER ARTIFICIAL CONDITIONS

Green tomatoes are low in vitamin C and in acidity. With normal ripening on the vines, vitamin C potency and acidity increase up to full ripeness. Tomatoes picked green and ripened with ethylene gas did not develop normal amounts of vitamin C and acidity. They averaged about 10 per cent lower in both materials. When they were ripened under the heat of electric lamps, there was more varietal variation. The content of vitamin C was from 2 to 21 per cent lower than for vine-ripened tomatoes. The acidity, however, was slightly higher. Similar samples were ripened in a dark oven at 26° F. The vitamin C content of these fruits was 8 to 10 per cent lower than that of vine-ripened fruits, but the acidity was 16 per cent higher. Thus, none of these artificial ripening methods resulted in as high vitamin C potency as was obtained in vine-ripened tomatoes, but in two instances the acidity was higher.

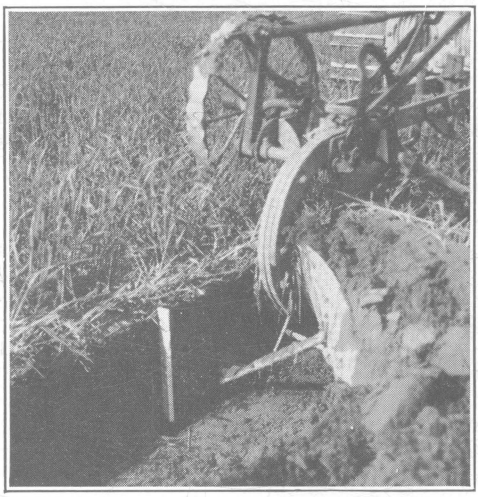
GREENHOUSE TESTS

Soil reaction.—Tomato plants growing in specially prepared alkaline, neutral, and acid soils were similarly treated except that half of them in each case were supplied with nitrate fertilizer and the other half with an equivalent amount of ammonium fertilizer. Under the alkaline soil conditions the vitamin C content of the tomatoes was about 14 per cent higher with nitrates than with ammonium nitrogen; the total acidity was lower. With neutral and acid soils the reverse was true for the vitamin, but the total acidity was slightly lower than where nitrates were used on the neutral soil. Under acid soil conditions ammonium fertilizers produced definitely higher acidity values. It should be pointed out that the tomatoes in this test under alkaline conditions produced considerably higher vitamin C potency with both nitrate and ammonium fertilizers than when similarly fertilized on neutral and acid soils.

SPECIAL ROTATIONS INCREASE POTATO YIELDS

On most Ohio soils the ordinary types of crop rotations are not suited to potatoes. Clover and timothy sods are not only likely to be infested with grubworms, but the liming to ensure legumes tends to increase the scab on potato tubers, and as a general rule the soil does not remain loose enough during the potato growing season. This has been the experience at the Experiment Station, even on Wooster silt loam, which is an excellent soil for grain and hay crops. For example, in a rotation of potatoes, wheat, and clover, the average yield of potatoes for 10 years was only 210 bushels per acre, even with 1,200 pounds of fertilizer per acre, good spraying, and certified seed.

Because the yield was below expectation, the rotation was distinctly changed in 1936. In a special effort to make the soil loose, a 2-year rotation was adopted with 1 whole year devoted to green manure crops. Corn was drilled thickly, about a bushel per acre, and the entire crop was plowed under in early August. In late August the field was sown to rye, which made an excellent fall growth. This rye sod was plowed early and the potatoes were planted early the following spring.



Dense growth of rye plowed 11 inches deep April 19, 1938

The yield of early potatoes on this block was 348 bushels per acre, of late potatoes, 410 bushels.

With only slight modification in the fertilizer, the yields with this new rotation were 349 bushels per acre in 1937 and 330 bushels in 1938. These yields were higher than had ever been obtained in the old-style rotation. The difference due to the rotation was more than 100 bushels per acre.

Additional rotation experiments indicate that it is the rye sod rather than the corn plowed down that is chiefly responsible for the excellent condition of soil. The important feature of the rotation then is the early seeding of the rye, which allows it to make the maximum fall growth and thus to develop a heavy sod.

DAIRY INDUSTRY

SILAGES OTHER THAN CORN UNDER STUDY AT STATION

Silages made from crops other than corn have been under study at this Station since 1922, when soybeans and corn were ensiled together with excellent results. Much of the work in the meantime has been on a small scale, with laboratory-sized silos, such as galvanized iron cans, large sewer tiles, and oil drums. Good silage has been made in these, but they are not adapted to securing quantitative data. The data obtained have, however, furnished a valuable background for planning and interpreting the results of later experiments

Up to 1937, 16 large silos had been filled with such materials as green oats, sweet clover, alfalfa-clover mixture, and soybean-corn mixture. In general the quality of the silage had a close relation to the quality of the materials put in, whether treated or untreated. In two cases where the crop was cut for hay and injured by rains, one with high dry matter content and the other with low dry matter content, the silages were of low grade but usable. In two other cases, where the dry matter content was 24 per cent, one treated with acids (A. I. V. silage) and the other untreated, both were somewhat off in flavor. The acid-treated was slightly the better. The mixtures of legumes with corn have been good. Corn is the standard silage crop so far as keeping quality is concerned.

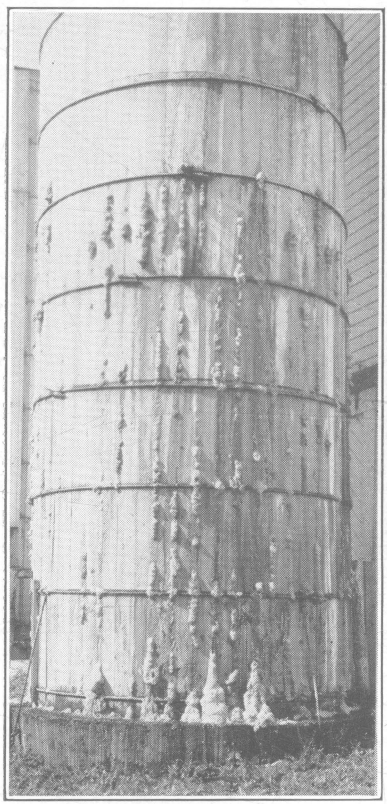
In June 1937, three small temporary snow fence and paper silos were filled with alfalfa. One was untreated, one was treated with molasses, and the third was treated with acids (A. I. V. silage). The untreated was opened in about 3 weeks and seemed excellent. It was closed and reopened about 10 weeks after filling. It contained good silage but too much was spoiled on top and about the sides. The one treated with molasses, opened later, contained more spoiled silage. The one treated with acids, opened still later, contained silage of the poorest quality and most spoilage, probably owing to the longer time rather than to the preservative used, and to the acids' injuring the paper and causing it to split. The paper in all the silos was broken in places by the pressure and sliding as the silage settled. The material was tramped well as filling progressed, but the paper wrinkled as the silage settled and there was not the close contact necessary to exclude air. Such silos are not recommended for keeping silage in hot weather. They probably would do better for late filling and winter use.

In June 1937, two silos were filled with alfalfa-clover mixture, one with the fresh-cut material containing 19 per cent of dry matter and untreated, the other with material wilted to 30 per cent dry matter and treated with 2 per cent of molasses (40 pounds per ton). Both produced good silage.

In July 1937, a silo was filled with second-crop alfalfa wilted in about 2 hours to 32.5 per cent dry matter. No molasses or acids were added and the silage was pronounced excellent.

In October 1937, alfalfa, clover, and fall grasses containing about 32 per cent of dry matter were ensiled with ripe corn containing 51 per cent of dry matter at the rate of 2.5 parts of alfalfa to 1 part of corn by weight. This made an excellent silage. Cows relished it and did well on it.

In May 1938, pasture herbage (bluegrass, dandelions, orchard grass) with a dry matter content of about 22 per cent was ensiled and treated with 2 per cent of molasses. There was a large loss of juice, but the silage was good and was fed up to 80 pounds per cow a day. Another silo was filled with the same material at 34 per cent dry matter content without treatment. A third was filled with the same material at 40 per cent dry matter and treated with 2 per cent of molasses. Both made acceptable silage but were a little off flavor. The molasses lot was slightly the better.



Juice leaking from clover silage in 20-ton silo

A 20-ton silo was filled with rank-growing medium red clover just coming into bloom and containing about 17 per cent of dry matter. The clover was allowed to lie for about 20 hours after being cut (poor curing weather), and went into the silo containing about 26 to 28 per cent of dry matter. The lower half of the silo was treated with 2 per cent of molasses diluted with twice as much water. The upper half was untreated. The top was kept well tramped and wet for a week. This silo leaked badly for more than 2 weeks, and much of the molasses and juice was lost. The silage was excellent and well relished by the cows. Practically no difference was observed between the treated and untreated, as would be expected with so much leakage. Probably the silage would not have been good if the leakage had not occurred. Three smaller silos were filled with the clover at 24.5 per cent dry matter. One was untreated, one was treated with 3 per cent of molasses, and the third with 4 per cent of molasses. The silage from all three was good and of about equal quality as indicated by appearance and palatability.

In April 1938, three small silos were filled with green rye 10 to 12 inches high and unchopped. The dry matter content of one was 15 per cent and the silage was worthless. In another the rye was mixed with chopped dry hay. It too was worthless. The rye put into the third silo was dried for 27 hours to 21.2 per cent dry matter. It was somewhat better, but still unsatisfactory.

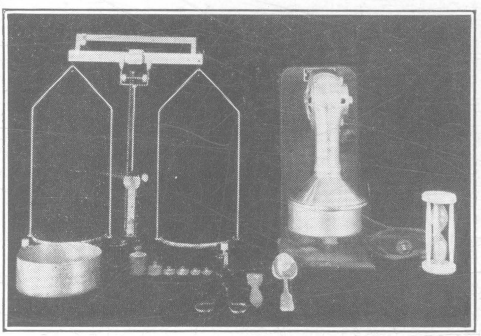
The carotene content of the silages reported varied. Generally the acid-treated carried the highest carotene content; the molasses-treated carried the next highest amount; and the untreated, the least, but more than sun-cured hay. There were some cases, however, where the carotene preservation was excellent without treatment, or with molasses. The carotene, or vitamin A, content of the milk produced by cows fed these silages was in line with the carotene content of the silage fed.

Although good silage can be made without the addition of preservatives if the dry matter content is controlled, it is recommended that 2 per cent of molasses be used until more experimental work has been done.

Surface spoilage is largely proportional to the care given the top of the silage. The surface should always be kept wet (not too wet) and tramped for several days after filling unless covered and weighted. A heavy sprinkling with salt helps to retain the moisture and prevent molds.

TEST RAPID METHOD FOR DETERMINING MOISTURE IN GREEN ROUGHAGES AND HAYS

An apparatus designed for moisture control in manufacturing processes has been tested for determining moisture in green roughages and hays. The results obtained in 15 to 30 minutes by this method have been reasonably accurate as judged by the results obtained when the same materials were dried for 24 hours in the oven by the usual method. Where electricity is available this method of obtaining quick moisture determinations is of value in making hay and hay-crop silages.



Apparatus used in the rapid determination of moisture in roughages

Left rear: balance
Right rear: drying machine with sample pan in position
Foreground: (left to right) sample pan, weights, tongs, brush, spoon, 10-minute time glass

The sample drier consists of an electric fan and heating element encased in a tube which is enlarged at the base. A removable pan containing the sample to be dried is held snugly against this base by a spring clamp. The bottoms of the sample pans are constructed of 500-mesh screening to permit the passage of air. The sample of roughage to be tested is weighed into the sample pan on a balance. The pan is then placed in the drier and a blast of hot air driven down through the sample until it is dry. This requires from 10 to 30 minutes, depending on the character of the material. The pan and sample are allowed to cool to room temperature, then weighed again. The loss in weight between this weighing and that made before the drying process was started represents the moisture driven off in drying.

MUST VEAL CALVES BE FED WHOLE MILK?

It has always been maintained that dairy calves must be fed liberal quantities of whole milk in order to make good veals at 7 or 8 weeks of age. Many times the value of whole milk is so great that this procedure is unprofitable. It would, therefore, be desirable to be able to raise good veal calves on a system of feeding that was less expensive than the whole milk method. With this in mind, trials were made with a commercial product, made largely from beef fat, which when mixed with skimmilk was supposed to simulate whole milk.

Thirty-eight Holstein male calves were raised to 50 days of age on whole milk and small amounts of grain and hay. Forty-six Holstein male calves were fed about 75 pounds of whole milk during the first 10 days and then skimmilk to which was added 5 per cent of the milk fat substitute. Because of a siege of scouring followed by pneumonia, suitable records were obtained on only 32 of the 38 whole milk calves and 27 of the 46 milk fat substitute calves.

When only those calves with satisfactory health histories are considered, the milk fat substitute appears to have made a creditable showing so far as its ability to promote growth and fat is concerned. The whole milk calves put on a little more weight (9 pounds more) and dressed a little better (8 pounds) than the milk substitute calves.

Observations were made on each carcass after slaughter. No particular advantage could be attributed to the whole milk calves so far as quality of the carcass was concerned.

When the cost of raising the calves to vealing age is considered, the use of the milk fat substitute was decidedly advantageous, costing only half as much as the use of whole milk.

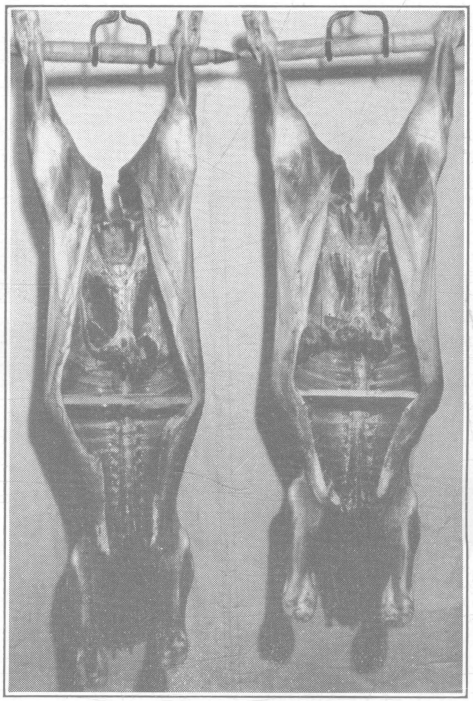
The difference in health histories of the two groups may be of significance. During the first 6 months of the experiment the 12 whole milk calves were finished with perfect health histories. During the same period, 5 out of 11 calves in the milk substitute group developed pneumonia. Examination of the livers of the calves from both groups showed considerable storage of vitamin A in the whole milk calves and practically none in the milk fat substitute calves.

During the next 6 months a cod-liver oil concentrate was given to some of the milk fat substitute calves. Five out of thirteen calves in the milk fat substitute group developed pneumonia, and only one of these five had received the concentrate. Three out of fifteen calves fed whole milk developed pneumonia during the same period.

During the third 6-month period the same cod-liver oil concentrate was fed to some of the milk fat substitute calves; some received the milk fat substitute fortified with vitamin A; and some received the plain milk fat substitute. During this period 5 out of 22 developed pneumonia. Two of these cases were light and three were fatal. Two of the three deaths occurred in the group receiving the unfortified substitute; the third occurred in the group getting the cod-liver oil concentrate, but could not be associated with diet, since the onset of pneumonia occurred shortly after birth. There were no cases of pneumonia in seven calves receiving the fortified milk fat substitute. Two out of eleven calves in the whole milk group developed pneumonia during this same period. One case was fatal; the other became chronic.

Although vitamin A may be concerned with disease resistance, there is no reason to believe that this factor can replace the fat of whole milk. A few calves were fed skimmilk plus a concentrated source of vitamin A. Fairly good

growth was obtained but the calves laid down little fat and the quality of the meat was poor. Since it is now known that fat is needed for the proper utilization of milk sugar, it is possible that the addition to skimmilk of vitamin A in some fat medium would result in better-quality veals.



Carcasses of calves raised to vealing age on skimmilk and a concentrated source of vitamin A

Note lack of fat.

If the greater incidence of disease in the calves fed the milk fat substitute was due to low vitamin A intake, this deficiency could readily be overcome by supplying additional amounts of this factor. A system of feeding such as that used in this trial offers promising possibilities for raising veal calves on a limited amount of whole milk.

RAISING HEIFER CALVES ON LIMITED AMOUNT OF WHOLE MILK

Many attempts have been made to reduce the amount of whole milk fed to heifer calves. The most drastic system involves eliminating milk when the calves are 3 weeks of age. As a rule calves raised on such a "dry feed system" are stunted for a short time after milk is withdrawn, and for 2 to 3 months their appearance is very rough. In an attempt to overcome this undesirable

transition period, a milk fat substitute – skimmilk combination was introduced when the calves were 12 days of age and continued for 7 weeks. At the end of that time skimmilk alone was fed until the calves were 4 months old. Calves so treated were compared with others fed whole milk for 21 days and then skimmilk until 4 months of age.

Three out of fifteen Holstein calves in the milk fat substitute – skimmilk group developed pneumonia, and two of them died while the calves were still on whole milk. In the whole milk – skimmilk group 3 out of 14 Holstein calves died from pneumonia.

At the end of 6 months the milk fat substitute – skimmilk group had gained 1.49 pounds daily, and the whole milk – skimmilk calves had gained 1.40 pounds daily. These gains are about average for the breed. In both groups the rough appearance of "dry-fed calves" was avoided, but the gains were no greater than those obtained previously with the dry feed system.

PELLETS COMPARED WITH MEAL FOR FEEDING CALVES

Some claim has been made that it is better to feed grain in pellet form than as a meal. A trial was conducted with Holstein heifer calves to test this point. A commercial calf feed in pellet form was fed as 50 per cent of a simple calf grain mixture and compared with meal made by grinding the same pellets. This meal was incorporated with the same calf grain mixture to the extent of 50 per cent.

Whole milk was fed liberally for 3 weeks and then gradually eliminated so that at 30 days none was fed. From then on until the calves were 4 months old the grain-pellet mixture and hay constituted the ration of one group and the grain – pellet meal mixture and hay that of the other group. From the fourth through the sixth month the only grain mixture fed contained corn, oats, bran, and linseed oil meal.

At the end of 6 months the pellet-fed calves (11) averaged 335 pounds; the pellet meal – fed calves (9), 347 pounds. Apparently there was no advantage in feeding pellets.

VITAMIN A DEFICIENCY MAY LIMIT REPRODUCTION

It has been known for some time that vitamin A deficiency causes sterility in animals. Under the usual conditions of feeding and management farm animals probably never receive rations completely lacking in vitamin A, although at times the amount of vitamin A in the ration may be low enough to limit reproduction.

A study has been made of the reproductive organs of animals receiving small quantities of vitamin A. Diets low in vitamin A but containing enough to prevent any marked outward symptoms of deficiency in white rats over a 13-week period following weaning resulted in definite damage to the reproductive organs. The cells of the testicle which give rise to the male germ cells (spermatozoa) degenerated, and complete failure of spermatozoa production or production of abnormal types incapable of fertilizing the female germ cell (egg or ova) resulted. Ovaries from the females in this test were definitely damaged but not to the same degree as the male testes.

Limited data from the study of testes from a bull calf which had received a ration low in vitamin A for a period of 8 months showed essentially the same changes to have taken place in the tissues which produce the spermatozoa as occurred in the more extensive experiment with rats.

It appears from the test with rats that the vitamin A requirement for normal reproduction is appreciably greater than the requirement for growth or protection against eye disease. In other words, the results indicate that diets containing sufficient vitamin A to prevent an animal from showing marked symptoms of A deficiency may not provide adequate protection against damage to the reproductive organs. This point has important implications, since dietary deficiency diseases are not frequent among farm animals, yet there are numerous cases of sterility and abnormal reproductive performance which cannot be explained on the basis of infections.

VITAMIN A DEFICIENCY AFFECTS PITUITARY

The pituitary body is a small gland at the base of the brain. Its secretions have much to do with the normal action of various body organs, including the sex glands. Damage to the sex glands seems to cause a typical change in the pituitary which appears to be an attempt to compensate for the damage.

One type of cell in the pituitary appears to secrete the material which regulates the activity of the sex glands. This type is called basophilic (stains with basic dyes). In last year's annual report it was shown that these cells in the female pituitary were increased from a normal of 6.4 per cent to 12.6 per cent in A-deficient rats and to 19.4 per cent when the sex glands were removed.

A study of the male pituitary now shows a greater increase of basophilic cells in the male than in the female. In the normal male pituitary there were 9.82 per cent; in the A-deficient animal, 21.06 per cent; and in the pituitary of the male from which the sex glands had been removed, 23.47 per cent. Although these data are from rats, examination of the pituitary from an A-deficient male Holstein calf showed a similar increase.

These data add to the evidence that for reproduction the male requirement for A is higher than that of the female.

FIND QUICK WAY TO TEST TOXICITY OF COTTONSEED MEALS

Unless chemical determinations for gossypol, the toxic principle in cottonseed meal, are made, the only way to determine whether a certain meal is toxic or nontoxic has been to feed it to pigs. If the meal is toxic, symptoms will appear in 7 or 8 weeks. It has been found recently, however, that guinea pigs will show symptoms of cottonseed meal poisoning much sooner.

Guinea pigs were fed rations containing 25 per cent of preautoclaved hydraulic cottonseed meal, preautoclaved hydraulic meal (iron treated), standard mill-run hydraulic meal, or pressure-cooked expeller meal. A positive control group received no cottonseed meal and was fed for a period of 59 days without mortality. Meanwhile, guinea pigs were dying off in some of the other groups, and the results showed the length of survival of the various groups to be: preautoclaved hydraulic meal, 11.5 days; preautoclaved hydraulic meal (iron treated), 51 days; standard mill-run hydraulic meal, 19 days; pressure-cooked expeller meal, 55 days.

As pigs (swine) now being fed these same meals are responding in a similar fashion, it is felt that the guinea pig method may prove valuable as a rapid means for determining toxicity.

ANIMAL INDUSTRY

TRY LESS CORN, MORE HAY IN RATIONS FOR FATTENING YEARLING STEERS

During the past few years farmers have been decreasing corn acreage and increasing the acreage in legumes. It has, therefore, become necessary to learn more about the performance of fattening cattle when the corn content of the ration is decreased and the hay content increased. Tests to determine the performance on such rations were conducted during the feeding seasons of 1935-1936 and 1937-1938 by the Ohio Agricultural Experiment Station. Choice steers weighing from 650 to 700 pounds were used.

Corn-and-cob meal was full-fed to lot 1 each year. Lot 2 was given three-fourths as much corn-and-cob meal as lot 1, and lot 3 was fed one-half as much corn-and-cob meal as lot 1. Legume hay, alfalfa with little exception, was fed in such amounts as the steers would eat. Lot 1 consumed, on the average, 13.25 pounds of corn and 3.25 pounds of hay; lot 2, 10 pounds of corn and 6.2 pounds of hay; lot 3 ate 6.75 pounds of corn and 8.75 pounds of hay. These feeds were fed in addition to daily feedings of 15 pounds of corn silage and 1.5 pounds of a 45 per cent protein supplement containing both vegetable and animal protein.

The average daily gains of lot 1 were 1.91 pounds; of lot 2, 1.78 pounds; and of lot 3, 1.69 pounds. The feeding periods averaged 240 days.

When the cattle were sold there was less difference in the selling value of lots 1 and 2 than their average daily gains indicated. In fact, for the last 2 years, no difference in selling price existed; for the first year lot 1 outsold lot 2 by 25 cents per hundredweight. There might have been a greater difference had the feeding period been shorter, because in all cases the lot 1 cattle showed considerably more finish than the lot 2 cattle at the end of 6 months on feed.

Lot 3 sold for 75 cents per hundredweight less than lot 1 at the close of the first two tests and for 85 cents less in the third test. This difference in selling values amounted to about $8 per steer.

If feed prices are set at 50 cents per bushel for corn, $3.50 per ton for silage, $10 per ton for alfalfa hay, and $30 per ton for supplement, the gains of lot 1 cost $8.24 per hundredweight; the gains of lot 2, $8.38 per hundredweight; and those of lot 3, $8.22 per hundredweight. These differences are not large enough to be significant.

If yields of 50 bushels of corn, 10 tons of silage, and 2 tons of hay per acre are used, lot 1 made 361 pounds of gain from the feeds, other than supplement, grown on an acre; lot 2 made 348 pounds of gain per acre; and lot 3, 351 pounds.

From this test it would seem that a ration similar to that used for lot 2 is worthy of consideration, but that the corn reduction made in the ration of lot 3 was too marked.

The question might be raised as to whether the increased amounts of hay fed to lots 2 and 3 might make possible some saving in the amount of supplement needed. This problem is being studied.

CONCENTRATES MAY HAVE INFLUENCE ON OCCURRENCE OF "APOPLEXY" IN FATTENING LAMBS

During the winter season of 1937-1938 a test was conducted to study the influence of various concentrates in the ration on the occurrence of "overeating" disease, or so-called "apoplexy", in fattening lambs.

Four comparable lots, each containing 67 western feeding lambs at the start, were fed a basal ration of shelled yellow corn, 0.15 pound of protein supplement, clover hay, and 1.25 pounds of corn silage. Lot 1 received the basal ration without additions or modifications. Lot 2, in addition to the basal ration, received 0.15 pound of protein supplement, or a total of 0.3 pound of supplement daily per lamb. Lot 3 received in addition to the basal ration, 0.3 pound of cane molasses daily per lamb. Lot 4 was raised on shelled corn, up to a maximum of 0.9 pound daily per lamb, and further addition of concentrate was allowed as whole oats. The question was, what effect will (1) a high protein allowance, (2) a laxative feed, (3) a bulky feed, have on the incidence of apoplexy?

The total death loss amounted to 4.1 per cent of the lambs fed. Only one lamb died in lot 3, fed molasses, and two in lot 4, fed oats. The other two lots suffered considerably higher mortality. The results suggest that the nature of the ration may influence the occurrence of apoplexy. However, the experiment will be repeated, to check further the significance of the results obtained in this trial.

SEEK WAYS TO CONTROL SHEEP PARASITES

Gastrointestinal parasites which infest sheep continue to be the greatest handicap to successful and profitable sheep production in Ohio. The development of effective methods for their control is the object of experiments carried on by the Ohio Agricultural Experiment Station.

One experiment in a series planned to determine the length of time the infective larvae of various parasites will survive and retain their viability on permanent pasture was completed during the year. To conduct this experiment, a permanent pasture plot was closely grazed by a parasite-infested flock during the summer and until November 1 of 1937, in order to establish parasite infectivity on the area. The plot was then kept free of sheep until June 8, 1938, a total of 220 days including the winter season. From June 8 until September 30, 1938, parasite-free lambs grazed on this plot. Post-slaughter examination of the stomach and intestines of these experimental lambs showed the following six parasites to be present: common stomach worm, encysting stomach worm, tapeworm, whipworm, *Trichostrongylus*, and *Nematodirus*; the latter two are small, round worms parasitic in the intestinal tract. Apparently, the larvae of these parasites had survived and retained their viability for the 220-day period, when the pasture was ungrazed. The flock used to infect the experimental plot was known to be infected with hookworms and nodular worms, in addition to the six parasites named, but neither of these was recovered from the experimental lambs. The results suggest, therefore, that these two species may have lost their viability during the 220-day period.

Another experiment on the control of gastrointestinal parasites was a study of the efficiency of various medicinal agents for the removal of parasites from lambs. Seven lots of 12 lambs each were used to determine the anthelmintic efficiency of tetrachlorethylene capsules, copper sulfate solution, nicotine sulfate solution, combination of copper sulfate and nicotine sulfate solution, and

sodium arsenite compound. One lot received no treatment (check lot) and one lot received the different treatments alternately. The lambs were grazed together on an infected pasture from June 29 to October 19, 1937. They received their respective treatments every 3 weeks throughout the test period. The results indicate that tetrachlorethylene was the most efficient. The order of efficiency for the others was: combination drench (1 per cent of copper sulfate in combination with 1 per cent of 40 per cent nicotine sulfate); copper sulfate (1.5 per cent solution); sodium arsenite compound; and nicotine sulfate (1.5 per cent solution of 40 per cent nicotine sulfate). The results obtained from the lot treated alternately suggest that the alternate use of two highly efficient vermifuges (tetrachlorethylene alternating with combination drench) would be a desirable practice to employ in farm flocks rather than the use of one treatment constantly.

LIMITING COCOANUT OIL MEAL IN PIG RATIONS IS ADVISABLE

Cocoanut oil meal is the ground residue from the production of oil from the dried meat of the cocoanut. It contains approximately 20 per cent of protein and about the same amount of fiber or woody material as oats.

When cocoanut oil meal made up a fourth of the ration and replaced both a part of the corn and a part of the protein concentrate fed to pigs, it showed a value 12.5 per cent greater a pound than that of corn.

When cocoanut oil meal made up two-fifths of the ration and replaced corn but no protein concentrate, its value was 88 per cent that of corn a pound.

A ration from which the protein concentrate was omitted but which contained a half more cocoanut oil meal than corn, so that it was as high as the other rations in total protein, was not satisfactory.

Cocoanut oil meal was also fed with skimmilk, ground alfalfa, and minerals but without corn. Its value as a complete substitute was 84 per cent that of corn a pound. Small amounts of ground alfalfa and minerals were fed with each of the various rations.

COTTONSEED MEAL MOST EFFECTIVE WITH OTHER PROTEINS

Mixtures (1) of equal parts of tankage and linseed meal, (2) of equal parts of tankage and iron-treated expeller cottonseed meal, and (3) of 1 part of dried skimmilk to 5 parts of iron-treated expeller cottonseed meal made excellent protein supplements to corn for pigs that were not on pasture. All were of about equal effectiveness. The iron treatment consisted of dissolving approximately 2 pounds of ferrous sulfate in 4 quarts of warm water and thoroughly mixing the solution with each 100 pounds of cottonseed meal.

LITTLE DRIED SKIMMILK BENEFICIAL TO YOUNG PIGS

Feeding dried skimmilk during the growing period only, and at the rate of 2.6 per cent of the ration, increased both the gain per unit of feed and the rate of growth of the pigs. The remainder of the ration consisted of corn, tankage, linseed meal, ground alfalfa, and minerals. After the pigs had reached a weight of 100 pounds or so, it did not pay to feed them dried skimmilk.

COMPARE HYBRID AND OPEN-POLLINATED CORNS FOR SWINE

Open-pollinated and hybrid corns of the Clarage and W17, of the Clarage and U. S. 52, and of the Woodburn and Iowa 939 varieties were compared in three tests for feeding to swine. The two corns used in each comparison were grown on the same farm. The hybrid corns were lighter in color, slightly higher in moisture, a trifle lower in protein, and had a greater percentage of kernels showing, under light, more extensive opaque or white starchy areas around the germ than the comparable open-pollinated corns.

The corns were shelled, ground, and mixed with the supplemental feed, and the mixtures were self-fed. In two of the experiments, the pigs that received open-pollinated corn ate a little more feed daily a head and made slightly faster gains and greater gains per unit of feed. In the other, they ate more feed and, except for one pig that did poorly, likewise made a faster average gain, but, because of this poorly doing pig or otherwise, made less gain per unit of feed consumed.

The average worth of the hybrid corns in the three comparisons was 2.4 per cent less than that of the open-pollinated corns. The pigs on the hybrid corns required an average of 8 days more time than those on the open-pollinated corns to fit them for market. The data are not regarded as sufficient to be conclusive.

CROSSBREEDING TESTS WITH SWINE BEING CARRIED ON

Duroc Jerseys, Poland Chinas, and Hampshires are being used in a series of crossbreeding tests at the Miami, Madison, and Paulding County Experiment Farms. At the start, in 1936 and 1937, part of the sows of one breed were mated to a boar of a different breed. For each succeeding generation, boars of the three breeds have been rotated and mated to crossbred gilts selected from the herd. The crossbred pigs are compared with purebred Duroc Jerseys on one farm, Poland Chinas on another, and Hampshires on the third. At the Paulding County Farm pigs of the three-breed cross outgained purebred Hampshires and also took slightly less feed per 100 pounds of gain than the purebreds. At the Miami County Farm a group of pigs of the three-breed cross made slower gains but took slightly less feed per unit of gain than purebred Duroc Jerseys.

TEST CRYSTAL VIOLET VACCINE FOR PREVENTION OF HOG CHOLERA

Hog cholera continues to make heavy inroads upon the swine industry. Serum-virus treatment is a very effective preventive measure, but the use of a virulent virus in this treatment is a hazard that prevents its being used for the complete eradication of the disease.

Experiments with crystal violet vaccine prepared by the method originally developed by the United States Department of Agriculture have been in progress at this Station during the past 3 years. During this time 14 different lots of vaccine have been produced and tested. Three points have been considered in these tests:

1. The duration of immunity to hog cholera following administration of the vaccine,

2. The possibility of the treated pigs spreading hog cholera through pen contact with susceptible swine,

3. The difference, if any, in the immunity following vaccine treatment, of pigs from serum-virus immunized sows and nonimmunized sows.

In these tests vaccine-treated pigs appeared to be entirely immune when exposed to hog cholera infection within 14 to 45 days after vaccine administration. When the exposures were made 75 to 90 days after treatment, the results were not so satisfactory.

No spread of cholera from vaccine-treated pigs to other cholera-susceptible swine held in the same pen was observed in any of the tests.

The resistance to hog cholera appeared to be no different in vaccine-treated pigs from immunized and nonimmunized sows.

The results of these experiments indicate that the vaccine as prepared cannot yet be considered a substitute for serum-virus immunization. Crystal violet vaccine may become a valuable agent in the control of hog cholera if the period of resistance following its administration can be extended to cover at least the usual feeding period of market swine, and if at the same time, the treatment remains free from danger of spreading the disease.

STUDY LONG INCUBATION PERIODS OF BANG'S DISEASE

The possibility of a long-delayed period of incubation (time elapsing between the exposure of the animal and the development of the disease) is an important factor in the control and eradication of Bang's disease. Because of it, pregnant cattle intended for addition to Bang's disease-free herds must be held in isolation for several months, depending upon the period of gestation of the cows at the time of purchase. If this period of isolation could be shortened, it would be a great advantage to the eradication program in most herds. It is, therefore, important that the conditions responsible for long periods of incubation be thoroughly understood, and investigations at this Station are now in progress to gain information upon this phase of Bang's disease.

These investigations have centered principally on the question of agglutinin development as it is related to the period of gestation of the animal at the time of exposure to Bang's disease infection. Pregnant cows and heifers held in individual isolation are being used as experimental animals in these tests. After the animals have been exposed to Bang's disease, blood samples are collected daily for agglutination tests. During the past year no unusually long periods of incubation have been observed.

MANAGEMENT MAY AFFECT PERFORMANCE OF PULLETS

This was the fifth year of the Station's experiments with different management procedures for the growth of chicks and pullets to determine how the livability and egg production of pullet layers may be affected by their previous management. The five management procedures were: isolated range, nonisolated range after 2 weeks, nonisolated range after 10 weeks, confinement to wire sun porch, and batteries.

After completion of the management phase of the project, the ready-to-lay pullets were managed the same. Pullets of each group were tested in individual laying batteries and in a floor pen. The isolated range, nonisolated range after 2 weeks, and wire sun porch groups yielded the best egg production with the

lowest rate of mortality, both in the laying batteries and in the floor pens. Although the pullets raised in batteries made the poorest record in the floor pen, they were among the best, both in egg production and in livability, when they were continued in laying batteries.

The most surprising part of these tests was the decidedly better livability of the pullet layers in batteries than in floor pens. In only 2 of the 25 tests during the 5 years did the mortality of the groups of pullets in batteries exceed that of the pullets in the floor pens. The average 5-year loss of pullets in batteries was 38.6 per cent, compared with 51.4 per cent for those in the floor pens. The average egg production on the basis of original number of birds was seven eggs per bird higher in the batteries than in the floor pens.

POULTRY RATIONS MUST CONTAIN VITAMINS

Good, complete rations are one of the essentials of economical livestock and poultry production. Such rations must contain not only the required amounts of proteins, minerals, carbohydrates, and fats, but the vitamins as well. A great deal of progress has been made in the study of the different vitamins. This is especially true in poultry nutrition.

One of the factors which has received detailed study in the past few years is vitamin G (riboflavin). Experimental studies with chicks have shown that riboflavin is necessary for growth, maximum utilization of feed, and prevention of "curly-toe" paralysis. Riboflavin is also essential for good hatchability. Hens on a ration deficient only in riboflavin produced eggs of which less than 10 per cent of the fertile ones hatched. The addition of adequate riboflavin to the same ration increased the hatchability of the fertile eggs to over 75 per cent in the course of 2 weeks. When the riboflavin was omitted from the ration again, the hatchability of the fertile eggs dropped from 80 per cent to less than 5 per cent in 2 weeks.

The common, practical sources of riboflavin are young grasses, and milk products, such as skimmilk, buttermilk, and whey. When poultry have access to green range, the riboflavin requirements are usually met by the tender grass consumed. For example, it was found that young oats, wheat, alfalfa, timothy, and bluegrass plants approximately 6 inches or less tall contained more riboflavin, on a dry basis, than dried milks. As the plant became more mature, the riboflavin content decreased materially.

Confinement of poultry, either chicks or layers, implies that some substitute for the green range must be provided in the ration to guard against a riboflavin deficiency. This can be most conveniently supplied by the liberal use of high-quality milk products and alfalfa meal in the ration. Experimental work in general has shown that an all-mash, practical chick ration should contain not less than 5 per cent of dried milk and 5 per cent of high-quality alfalfa meal, or their equivalent, to furnish adequate amounts of riboflavin. Laying mashes which are commonly fed with scratch grains should also contain the indicated amounts of dried milk and alfalfa meals, or their equivalents.

HOME ECONOMICS

FOOD NEEDS OF YOUNG ADULTS OBJECT OF STUDY

What are the food needs of the human body? How can they be provided? Finding the answers to these questions is of vital importance to individuals and to society at large.

Many studies have been made and are still being made concerning the nutritional needs of individuals during periods of reproduction, lactation, and early childhood. Studies have been made on the food needs of adults. Very little has been done, however, in measuring either the growth and development or the dietary needs of young adults.

A comparison of the results of dietary studies made in 1894 with results of similar studies made in 1930 shows a decided decrease in calorie intake of young women. As food intake decreases, increasing care in selecting food to provide for protein, minerals, and vitamins is needed.

During recent years sugar consumption per capita has increased greatly. Increased use of sugar, a fuel food, brings about a decreased use of body-building and body-regulating foods. Modern methods of processing cereal foods, and of storing fruits and vegetables often bring about some decrease in their mineral and vitamin values. The decreased food intake, along with the increased use of sugar and of highly milled cereal products, makes it necessary to plan carefully for adequate provision of protein, minerals, and vitamins.

Many young women are interested in maintaining a fashionably slender figure and therefore restrict their food intake. Unless reduction diets are very carefully planned to include foods to provide protein, minerals, and vitamins, such reduction diets are very likely to be lacking in the important body-building and body-regulating substances. Thus, there is danger that many young women are not providing for their food needs adequately.

With the need for further information about the nutritional status of young adults and their food requirements in mind, workers connected with the home economics departments of the Experiment Stations of Minnesota, Wisconsin, Nebraska, Ohio, Iowa, and Kansas are cooperating in a study of the nutritional status of college women as related to their dietary habits. The study has been planned so that all the workers are following similar procedures. The year 1937-1938 was the second year of the study.

Several lines of study are being followed. Body measurements, basal metabolism observations, and studies of the formed elements of the blood are of service in assessing the nutritional condition of individuals. Added to such measurements, observations of the amounts of protective foods used by young women and the extent to which certain nutrients are retained in the body are of service in gaining some idea of the nutritional status.

Results of measurements in Ohio and three other states show little difference in size of women 17 to 23 years of age. As measurements on individual women are repeated during each of 4 years, age differences may become evident. The Ohio women averaged less in weight and slightly shorter in height than the women from Iowa, Kansas, or Minnesota. The fact that Ohio is more predominantly urban than the other states concerned in the study may be a factor.

Basal metabolism studies of Ohio State University women showed their average heat production to be below the standards usually accepted, but midway between the heat production of girls of high school age and that of older women as previously determined in this laboratory. Are the standards too high, or is the lower basal metabolism rate found among the Ohio State University women connected with a lower nutritional plane? These are questions upon which further data may throw some light.

Dietary habits do not always reflect the teaching of the findings of nutritional research. Study of the dietary habits of the freshman women showed them to be no exception to this generalization. The use of the protective foods, milk, vegetables, and eggs, by these young women was less frequent than is considered desirable. By spending the same amount of money, but by redistributing the expenditures, by shifting emphasis from one type of food to another, these young women could improve their dietary habits and their own well-being at the same time.

The degree to which nutrients are retained in the body, the relation of the amount excreted to the amount ingested, throws light upon the amounts of nutrients needed. Calcium, phosphorus, and nitrogen balance studies are being carried on. In Ohio, eight girls have been studied for 10 consecutive days, one girl for a total of 42 days, and another girl for a total of 37 days. The results of many such balance studies should enable nutrition workers to set up dietary standards for young women of the ages studied and should give a basis for nutritional teaching in regard to amounts of calcium, phosphorus, and protein needed at such ages.

In order to make the various measurements outlined, the active cooperation of the young women who act as subjects is necessary. The nature of the study brings to these young women's attention factors concerned with their own growth, development, and well-being. All this is educational and should help the young women realize that nutrition is a factor of primary importance, also, that the individual has a responsibility not only to herself but to society at large in maintaining the best possible nutrition.

COMPARE GLASS CURTAIN FABRICS

A study has been undertaken in answer to questions that arise regarding the selection and care of cotton and rayon glass curtains. The fabrics now being tested include cotton and rayon marquisette, cotton and rayon voile, scrim, filet, and cotton bobbinet. These fabrics have been subjected to determinations of width, thread count, thickness, fiber composition, number of plies in yarn, and fabric structure. Samples of all the fabrics have been exposed to sunlight for 100 hours, and other samples are now being exposed in the Fade-Ometer and in diffused light from a north window. During the coming year, further tests of the physical characteristics and laundering properties of these fabrics will be conducted.

RURAL ECONOMICS

OHIO AGRICULTURAL INCOME WAS $343,000,000 IN 1937

A recently completed study of the agricultural income of Ohio shows that in the year 1937 Ohio farmers received a total of $335,000,000 from the sale of farm products. To this might be added the $8,000,000 received from agricultural conservation payments to make a total of $343,000,000. Among the counties, Darke ranked first in agricultural income, Wayne second, and Wood third.

In 60 of the 88 counties in the State dairying was the leading source of agricultural income. In 22 other counties it ranked second. Hogs ranked first as a source of income in 23 counties and second in 17 others. Although poultry ranked first as a source of income in none of the counties, it ranked second in 30. In two counties greenhouse products ranked first as a source of income. Nursery products, fruit, and tobacco were each first in one county.

Although wheat is one of the important sources of income to the Ohio farmer, there were only five counties where it ranked as high as second.

STUDY AGRICULTURAL CONSERVATION PROGRAM

In a study of the agricultural conservation program in Licking County and six surrounding counties started in 1938, information was secured relating to 506 farms. About one-half of them were in Licking County; the others, in adjacent bordering townships. Of the total number, 185 had participated in the 1937 conservation program. Of these, 56 had cooperated in the agricultural adjustment programs during each of the 3 years 1935, 1936, and 1937. A total of 127 had cooperated in each of the years 1936 and 1937. On the other hand, 222 farmers had not cooperated in any of the programs for the past 3 years. It was found that 86 of the 321 farmers who did not cooperate in 1937 could have participated without making any change in their crop acreage for 1937. Either lack of information or opposition to the program kept them from making application for payment. The remaining 235 noncooperating farms were smaller, on the average, than the participating farms. Nearly 70 per cent of their cropland was devoted to depleting crops as compared with about 56 per cent for the cooperators. Combination of a felt need for a larger proportion of corn and other depleting crops together with a somewhat less favorable depleting base or allotment kept many of these farmers from participating in the 1937 conservation program.

In six Licking County areas it was found that nonparticipating farms were depleting their soil 50 per cent faster than those cooperating in the program.

COMPLETE STUDY OF MILK MARKETING

A study touching the experience of approximately 400 farmers in marketing whole milk has been completed. Data were collected from five different areas where farmers sell whole milk for city consumption or for manufacture.

A most significant angle of this problem of finding a milk market is the question whether the present situation affords an open opportunity for farmers to enter the whole milk market when they desire to do so. In general, the

areas covered have ample supplies under inspection to meet city requirements. In the 3 years 1935, 1936, and 1937, there have been a very small number of producers taken directly into the city fluid milk markets. In 1936 a small block of producers was taken from the cheese plant area and incorporated into the Stark County organized market. In 1937 one buyer in the Dayton market added a block of milk in Indiana to the inspected supply for city distribution. In the main there has been little chance for a producer to enter the city market directly.

There has, however, been almost unlimited opportunity for farmers in these and other areas to attach themselves to plants manufacturing evaporated and condensed milk. There has been a marked increase in the number of outlets open to farmers in this field. Some of these plants have very rigid sanitary requirements for a part of the supply purchased, but in most areas a farmer can start into a whole milk outlet with but little or no addition to the sanitary requirements for producing sour cream.

The returns to individual farms selling whole milk vary greatly. The measure regarded as the best index is the average returns per 100 pounds at the farm for milk adjusted to a 3.5 per cent butterfat basis. To this are added hauling charges to arrive at the average return per hundredweight for milk of 3.5 per cent butterfat content at the market.

Sixty-seven Medina County milk producers in 1937 received yearly average returns for 3.5 per cent butterfat milk sold, of from $1.69 to $2.60 per hundredweight. A part of this variation in returns was due to the quality of the milk offered for sale. Most of it was due to economic factors, such as the market outlet, the use to which the milk was put, and the purchasing plan in effect. Opportunity for farmers in this area to change markets was found to be strictly limited.

TRANSPORTATION COST IMPORTANT IN MARKETING OF LIVESTOCK

One of the important costs in marketing livestock is transportation. Twenty years ago transportation of livestock meant railroads. Today, except for the long hauls, livestock transportation means motor trucks. Because of this shift from rail to motor transportation, agencies marketing livestock have changed. The direct marketing of livestock has increased, and livestock auctions have sprung up all over the corn belt, numbering 75 in Ohio, July 1, 1938.

The rate charged or the cost for the use of motor trucks is all important to the farmer consigning livestock and to the drawing power of the trade area of the livestock markets. Likewise, the rate is important to market operators, stockyard companies, and livestock auctions making investments in new facilities or repairing old. Therefore, the Department of Rural Economics has been studying this basic factor in livestock marketing. Two previous studies, reported in Bulletin 440, August 1929, and Bulletin 531, December 1933, have been issued. At the present time the Department is studying the motor transportation rates at the three important livestock markets in the State, Cleveland, Columbus, and Cincinnati.

Rates charged for moving livestock to Cleveland during 1937 and 1938 were in general from 30 to 40 per cent lower than they were in 1929 and 1930, depending on species and location. Sheep and lamb rates have dropped the most, and calf rates the least.

With very few exceptions the motor transportation rates for cattle were the lowest; those for hogs and sheep next; and calf rates, the highest. For a selected group of towns these rates averaged: cattle, 30.5 cents; hogs, 32.6 cents; sheep, 36.9 cents; and calves, 42.6 cents for moving 100 pounds to destination from origin. The towns from which these averages were obtained were in the group of towns 50 to 100 miles from Cleveland.

Another very interesting fact concerning livestock rates is the relative rate charged for trucking various distances. As rates to the Cleveland market have evolved and developed during the past years, it made little difference in the rate charged in 1937 whether the hogs were transported 40 miles or 160 miles. As a matter of fact, the rates per 100 pounds were less for distances around 100 to 130 miles than they were for distances from 30 to 60 miles.

The lowest zone rates were found when hogs were trucked 110 to 120 miles. As the distance increased beyond 120 miles, the rates tended to increase slightly with the greater distance. This tendency in rates to be approximately the same for transporting hogs is difficult to understand, for the rate would be expected to increase as the distance increased. This study has not been pursued far enough to note whether this condition will be found at Columbus and Cincinnati. Data so far analyzed indicate a similar situation.

The main point to remember concerning the development and the basis for rates is that farmers located within 30 to 50 miles of a terminal market have no other alternative than to go to the indicated market. Hence, truckers can keep the rates somewhat higher. However, farmers situated 125 miles or more away usually have several alternative markets, and often the possibility of shipping by rail. Therefore the rates must be kept low in order to get the volume to move by truck to the market some distance away. Also, it must not be forgotten that the rate paid includes not only the cost of truck operation, but also other costs, such as time and trouble of loading, soliciting, and obtaining the livestock to move by truck.

It is important to know the trend and development of rates for the transportation of livestock in order to understand the shifts, changes, and trends in marketing institutions.

LEGISLATION AFFECTING AGRICULTURE

In the 135 years of our history as a State, the people of Ohio have adopted a mass of state legislation dealing with agriculture. During the past year this legislation has been studied with the aim of assembling it into an orderly, intelligible classification. Particular emphasis has been given to legislation which in some way indicated the development of a public policy in respect to agriculture.

Practically all of this legislation can be classified under one of the following three heads: (1) regulation and control under the police power of the State; (2) authorization of various types of voluntary associations; and (3) creation of certain public institutions or publicly managed services administered by some department of the State or its subdivisions.

Falling under the first head are legislative acts dealing with public health, purity of foods, control of animal and plant diseases and insect pests, weights and measures, commercial fertilizers, livestock feeds, seeds, insecticides, hunting and fishing, forest fires, and the like. These are examples of things which experience has demonstrated need some type of public supervision under the police power in order that individual and public welfare may be protected.

Under the second head, legislation dealing with voluntary associations of individuals, comes the development of various types of corporations, particularly cooperatives, such as mutual insurance associations and cooperative trade associations.

Under the third head, legislation dealing with certain public institutions and publicly managed services affecting agriculture, comes a series of developments in education and research. In chronological order of development these have been: (1) public support of agricultural societies, (2) the College of Agriculture, (3) the Agricultural Experiment Station, (4) farmers' institutes, (5) agricultural extension, and (6) agriculture in the public schools. Other publicly managed services of particular interest to agriculture are: (1) the development of a highway system and the formulation of policy in respect to its management and finance; and (2) the development of legislation which in general affects rural land use. Examples are drainage districts, sanitary districts, conservation districts, park districts, and state and municipal parks and forests.

Ohio's original institutions and laws were patterned after those prevailing at the time the State was organized. But, starting from this point, the developments mentioned before are the result of influences which arose with such changes as population growing from 45,365 in 1800 to nearly 7,000,000 at present; agriculture expanding to cover nearly all available land; urban industries becoming the source of livelihood for much of our population; problems developing in respect to natural resources in soil, timber, waters, and minerals; and the development of science and invention throwing innumerable crosscurrents into our economic and social life.

Practically all legislation related to agriculture has been enacted on the assumption that it in some way served the public welfare; the idea has been that agriculture as a basic industry affects the well-being of all the people. As the years pass, the tendencies in lawmaking are influenced by the emergence of new situations or by new implications placed on old conditions. For instance, the meager public health regulations in the pre – Civil War period were greatly expanded between 1870 and 1910, owing largely to the advancement of scientific knowledge of microorganisms causing disease. In respect to rural land use, the drainage laws were fairly well developed by 1860; the problem then was the disposal of surplus water. Since 1910 attention has centered more on the conservation and development of natural resources and on systematic planning for the best land use. Agricultural education has developed with the passing years through the adoption of new methods of approach to rural problems. The dominant tendency in educational policy has been to broaden the scope of activity in order to contact and benefit more people, both old and young. It is now recognized that education in a changing world must be a continuous process. Agricultural cooperatives have passed through two cycles of legislation. In the first, following the Civil War, the concern was to write cooperative principles into corporation law. In the second cycle, following the World War, the purpose was to reshape the legal framework of cooperative associations and, of equal importance, to establish the legal difference between farmers' cooperatives and business trusts.

The study indicates how the mass of legislation enacted in Ohio conditions economic and social relationships and, to a considerable extent, affects the environment in which we work and live. The historical approach used is intended to portray the reasons why different laws have been enacted and how these laws have developed into a pattern of agricultural policy.

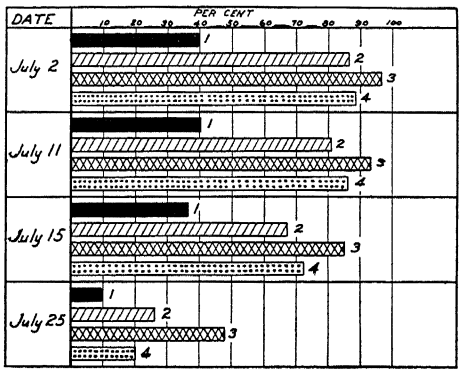
AGRICULTURAL ENGINEERING

VARIOUS WHEATS TRIED FOR COMBINE HARVESTING

During the past year, investigations were made to determine the adaptability of various varieties of wheat to efficient combine harvesting. The varieties included Trumbull, Gladden, Fulhio, and Nigger and were grown at Columbus.

There was very little difference between the various varieties in rate and evenness of ripening, and practically no shattering existed even at the end of a 14-day period following completion of combine operations.

Stiffness of straw is an important factor for combine operation. If the straw is weak, the heads of grain will sag to the ground and a heavy cutter bar loss will result. Large rack and shoe losses will occur if the straw breaks up readily by the cylinder and thereby prevents rapid separation of the grain from the straw and chaff.

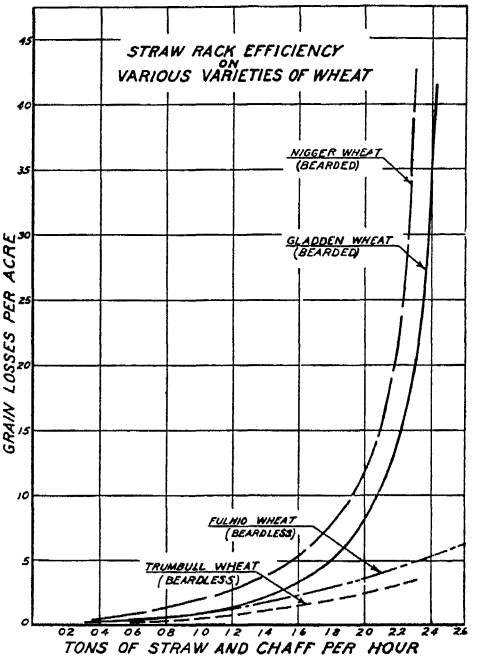


Percentage of standing straws in various varieties of wheat

1, Trumbull
2, Gladden
3, Fulhio
4, Nigger

The sagging of the heads of grain may be caused by the bending or breaking of the straw, which varies greatly with the variety of grain. On July 2, the date on which the grain was ready to combine, 54.8 per cent of the straws of the Trumbull variety were bent with the heads of grain only a few inches from the ground. The Fulhio variety showed only 2.5 per cent of bent straws, and the other two bearded varieties were only slightly above this figure. Most of the bending of the straw occurred during or after a rain and at the upper node on the stem. Bending seems to be more serious than the breaking of the straw. On July 2, the maximum percentage of broken straws on any variety was only 6.1 per cent, but on July 25, the maximum was 32.2 per cent. On both of those dates the Trumbull variety contained the most broken straws, and Fulhio, the least. On July 2, only 39.8 per cent of the straws of the Trumbull variety were

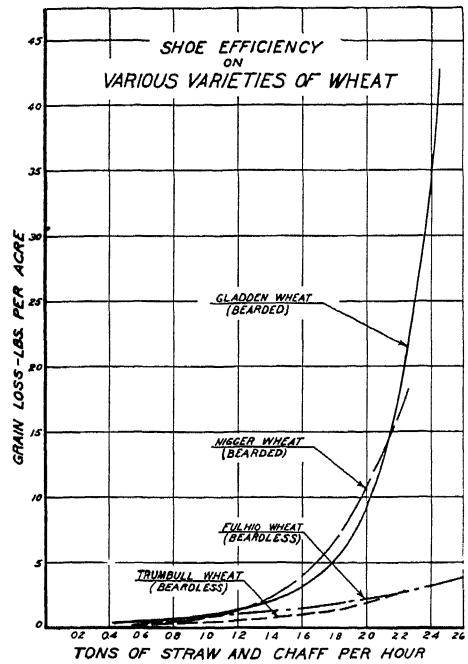
classed as standing or erect; the other varieties varied from 86.2 to 96 per cent. This condition was reflected in the grain loss back of the cutter bar of the combine. At a 14-inch stubble the Trumbull variety showed a cutter bar loss of 40 pounds per acre. The other varieties varied from 2.5 to 30 pounds per acre.



The apparent smaller amount of lodged straw in the Fulhio variety as compared with the Trumbull was contrary to expectation, and may have been due to a peculiarity of the season. Many years of observation of both Fulhio and Trumbull at several locations in the State have shown that Trumbull has the stiffer straw.

From the straw rack and shoe efficiencies it was evident that the grain losses at these two areas were greater with the bearded varieties than with the beardless varieties. It was also evident that these losses started at approximately 1.3 tons of straw and chaff per hour through the machine and reached extreme heights at 2.4 tons per hour. The straw from the bearded varieties broke up more readily than that of the beardless varieties. This condition, together with the beards, had a tendency to close the openings in the straw rack and shoe, which resulted in the loss of grain over the rear of these two units.

Several inconsistencies resulted in the cylinder losses of the four varieties, and the work will be repeated to establish more accurate results. The milling qualities of combined and shocked grain were also obtained, but at this time the results are not ready for publication.



CORN CRIB PRESSURES MAY INCREASE IN SPRING

A corn crib that holds up at time of filling may have its sides pushed out the following spring when damp weather follows the dry winds of March and April. The dry corn will expand when it absorbs moisture from the damp atmosphere and thus cause a great increase of pressure against the walls. This is one of the results obtained from the study of corn pressure on crib walls conducted for short periods during the past few years.

DISTRICT AND COUNTY EXPERIMENT FARMS

During the year the outlying District and County Experiment Farms continued the usual varied lines of work, including fertility, variety, meadow, pasture, livestock, orchard, and other projects, which fitted into the general research scheme of the Ohio Agricultural Experiment Station.

On practically every Farm can be found some timely work bearing on the many problems that have been brought to the front by recent interest in soil conservation and consequent crop adjustment. An occasional observation of the value of soil conservation may present a more striking lesson than the most impressive figures from comparative short-time plots. At both the Northeastern and Southwestern Experiment Farms there recently has been occasion to plow up some driveways that had been in grass for many years, perhaps a quarter of a century or longer. These were planted, one to potatoes and the other to tobacco. Alongside, the same crop, with the same cultural methods, was grown on land that during all these years had been in supposedly good rotations and had received liberal fertilizer treatment. The result at the one Farm on land somewhat too heavy for potatoes was an extra hundred bushels of potatoes per acre on the grass drive. The tobacco yields of this year on the other Farm are not yet available, but as seen in the field, the difference was strikingly in favor of the former grass drive.

To secure the maximum benefits of legumes and grass sometimes necessitates the outlay of a considerable number of dollars per acre for soil-improvement purposes. Results at the Trumbull County Experiment Farm show that for the northeastern section of the State the money invested in limestone and fertilizer is most quickly returned if a clover-alfalfa-timothy mixture is sown and the resulting meadow left down for 2 or 3 years. On this heavy type of soil the alfalfa-stimulated timothy naturally makes a superior growth the second year. Average yields the first year, when clover predominates, have been about 2 tons, compared with nearly twice this the next year, when alfalfa and timothy predominate. Inasmuch as the following high-cost corn crop has averaged only 60 bushels per acre, the quickest return has been secured with the utilization of the low-cost second-year alfalfa-grass meadow. Leaving it down a third year may be still more profitable.

Evidence at both the Trumbull and Belmont County Experiment Farms indicates that on many dairy farms from two-fifths to one-half of the rotated area kept in meadows will provide sufficient hay to fill the mows, perhaps even a silo, and also furnish the necessary rotated pasture to supplement the white clover and bluegrass during certain critical periods of the summer and fall. Such was the case at the Trumbull Farm this past season. Under the pasture conditions thus made possible from April to September, a considerable cut in grain feeding was made on one-half of the herd without any serious reduction in milk yield. In fact, the cows showed more tendency to reject a portion of their grain allowance during late summer on second-growth rotated pasture than on luxuriant bluegrass and white clover in May and June. The two groups,

supplied liberally with hay in winter and pasture in summer, will be continued on different levels of grain feeding to determine the cumulative effects in future lactations.

On the Southeastern Experiment Farm, as well as on the Washington, Clermont, Hamilton, and Miami County Experiment Farms, something has been done in growing alfalfa or sweet clover in permanent bluegrass pastures. With proper methods, which involve March sowing on disked sod and care in grazing for the first several months, there has been no particular difficulty in getting these legumes established. Natural reseeding of sweet clover 2 years later has not been as heavy as desired, especially where a thickening of the bluegrass sod had taken place. Both crops have been more easily established in sections where the soil and subsoil contain a liberal supply of limestone than in those where acid conditions have made necessary a surface application of limestone. At the Miami County Experiment Farm, where the mixtures have worked best, some surplus alfalfa-bluegrass pasture has been made into hay in June; the alfalfa-bluegrass and sweet clover – bluegrass combinations have made more July and August pasture than white clover – bluegrass; and the stimulation of bluegrass after second-year sweet clover has made a large amount of late fall pasture. On acid soils where surface liming is required the results have not been such as to create a lot of optimistic interest.

Clipping tests at the Southwestern Experiment Farm are showing some of the management features necessary to the maintenance of a desirable proportion of white clover in a permanent bluegrass pasture.

At the Paulding County Experiment Farm, where previous fertilizer tests have failed to indicate the solution of the soil problem, more recent rotation tests are very encouraging in the beneficial results obtained from keeping alfalfa and grass mixtures in the rotation for 2 or more years. These results indicate the feasibility of more livestock in this section, which has been devoted largely to grain and sugar beets.

A large proportion of meadows automatically brings about reduced corn acreage. Silage growing and feeding tests at the Mahoning and Madison County Experiment Farms show that the returns from such reduced corn acreages can be compensated for by growing superior hybrids and putting a larger proportion of the acreage into the silo.

FORESTRY

The desire for wholesome recreation and the search for new and valuable resources have combined to bring the potentialities of forest land into sharper focus.

Forest recreation on public land is being looked upon more and more as a legitimate reason for the purchase of forest land by the state and lesser governmental agencies. It takes its place along with the protection of the soil against erosion, the production of commercial timber, and the elimination of agricultural slums in justifying the expenditure of state funds for the purchase of land for state forests and state forest parks.

If state forests are to serve the recreational needs of Ohio's many centers of dense population, it is obvious that distances to the forests must not be too great. Fortunately, potential state forest areas can be found within easy driving distance of most large cities.

Usually it is possible to find rather extensive areas which if purchased and reforested would not only contribute to recreational needs, but would also serve other economic and social needs as well.

Land used for a highway serves but one purpose, that of transportation; land planted to corn yields only corn; but forest land enjoys the unique distinction of serving many purposes at the same time. Use of the land for picnicking, camping, hunting, and fishing has not been found incompatible with the use of the same land for the growing and harvesting of a timber crop.

STATE FORESTS IMPORTANT RECREATION AREAS

The rapidly increasing recreational use load of the state forests has in some instances been relieved by the opening up of new areas, notably those purchased and developed by the Resettlement Administration. The Ross-Hocking Group Camp, which was operated for the first time this season, was used to capacity. The Camp is for organized groups and will accommodate 150 persons. The eager and enthusiastic campers suggest a need for additional facilities of this kind.

On the McArthur Unit, which is also a Resettlement Area, an 80-acre lake is about complete. Near the dam are a beach, bathhouse, and diving tower. On a point overlooking the lake is a group of 14 vacation cabins which will be ready for occupancy in 1939. The cabins will be completely equipped.

Negotiations for the turning over of these two areas, together with a third tract at Zanesville, to the Ohio Division of Forestry for administration, are under way and may be consummated late in 1938. All three will be valuable additions to the recreational facilities of the State.

A swimming pool and bathhouse project got under way at Bryan Park in Greene County as a cooperative project of the Boy Scouts, the 4-H Clubs Camp Inc., and the State. This pool is expected to be ready for use in 1939. Here also the CCC has been working on a road which will connect the John Bryan Park with the Edward Orton Park.[1]

[1]The Edward Orton Memorial Park is a gift to the State from Hugh Taylor Birch of Yellow Springs, Ohio.

One of the 14 vacation cabins constructed by the Farm Security Administration under the sponsorship of the Division of Forestry

The dam on the Scioto Trail Forest is now complete and work is under way on a public use area that will accommodate about 1,000 people. A closed shelter that can be heated for late fall and early spring use is a feature of the development of this area.

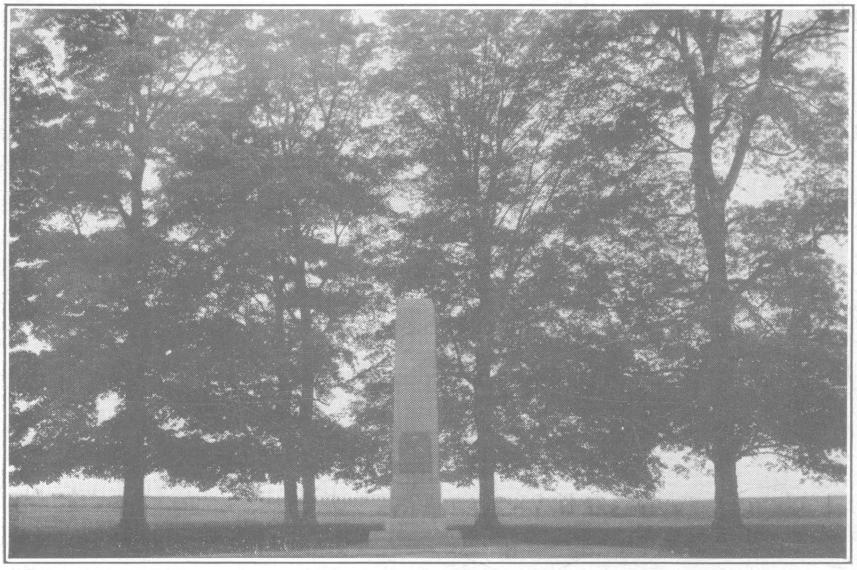
This season saw nearly a 100 per cent increase in the visitors on the Shawnee Forest in Scioto County. A map showing the state land, the territory immediately adjacent thereto, and the roads, trails, and interesting features of the Forest has been published and is available upon request.

ACQUIRE NEW LAND FOR STATE FORESTS

The acquisition of land for state forests and forest parks has been confined largely to lands which were optioned the previous year. Options on two small tracts have been taken, but in general, purchase has been suspended, owing to shortage of funds.

Lands paid for during the year amounted to 2,640.27 acres. The total purchase price of $16,797.68 makes an average for the forest park land of $15 per acre, and for the forest land, $5.39 per acre. The maximum paid for forest park land was $18 per acre, and the minimum paid for forest land was $3.50 per acre.

In addition to land acquired by purchase, 513.48 acres were added to the Findley State Forest by Mr. and Mrs. Guy B. Findley, and 86.62 acres were added to the Edward Orton Memorial Park by Mr. Hugh Taylor Birch.



The lands adjoining John Bryan Park which were given to the State by Mr. Hugh Taylor Birch have been dedicated to the memory of the late Edward Orton.

Part of an abandoned farm now included in Mohican Forest, 1 year after planting with white pine

A very substantial increase in the area of the Mohican Forest will occur when a proposed land purchase program under the Bankhead-Jones Act is approved. This program will be confined for the time being, to Hanover Township, Ashland County, but may be extended later to take in land on each side of the Mohican River south of the present Forest. This would not only place in public ownership some of the finest native stands of white pine in Ohio, but would also create a potential recreation area unexcelled in the State.

Considerable interest is developing in converting land no longer suited for agriculture into state forests. Forestry is being recognized as a means of producing a crop on worn-out and eroded lands, but the nature of the problems involved does not make reforestation attractive to private capital. In the interests of the general public, the land should be placed in production, and public ownership appears to be the only solution.

Sooner or later the transfer to public ownership of large tracts of privately owned land would effect a noticeable reduction in real estate taxes. Even though a reduction might also occur in the maintenance load of roads and schools, some counties might suffer a permanently curtailed income. Compensation for this possible loss might be obtained by returning to the counties a portion of the net income from the sale of forest products.

FOREST FIRE PROTECTION URGENT NEED

Federal funds for forest fire protection available under Section 2 of the Clarke-McNary Act were increased at the last session of Congress from $1,600,000 to $2,000,000. From this increase Ohio received $1,000, which tended, in a small measure, to offset the loss of four CCC camps from an area where fires have always been numerous and difficult to control.

Abundant rains in the spring and autumn tended to lower the loss from fires during the year, although improved detection, obtained as a result of more lookout towers, together with thorough training schools for CCC enrollees, has helped to keep down the size of the average fire.

During the fall fire season 81 forest fires were extinguished. These fires burned 511.7 acres of woodland, or an average of 6.32 acres per fire. The record for the spring of 1938 is also encouraging, with 288 fires burning 1,382.4 acres for an average of 4.8 acres per fire. This still falls short of the goal of one-tenth of 1 per cent of the area protected as an allowable maximum.

Within the area receiving organized forest fire protection, only 1.14 acres in every 1,000 suffered any fire damage. The cost of protection is approximately 1 cent per acre per year. It should be clearly pointed out, however, that favorable climatic conditions during the two fire seasons cannot be depended upon, and that during an average or severe season, adequate protection might cost in excess of 2 cents per acre.

The loss of a CCC camp increases the protection costs in the locality which the camp served. In these communities registered crews are selected and trained. These men agree to remain within reach on days when the woods are dry and can be called into action by any towerman, warden, or forest ranger. In some instances it has been difficult to find satisfactory crew members, but under normal conditions the plan is satisfactory.

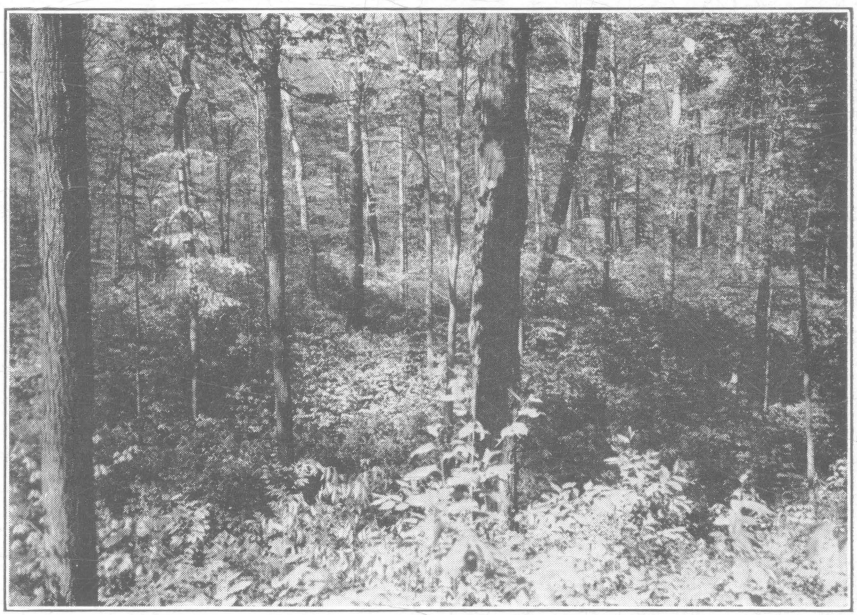
The apparent results of educational work in the prevention of fires point the way to a very fruitful field of endeavor. Reports of going fires are now being turned in by people who have received instructions from radio programs.

Much good could be accomplished by teaching the story of forest fire protection to children of school age. Adult education by means of radio, screen, and press produces gratifying results.

Because of limited funds, protection can be extended to only 1,700,000 acres of the 2,800,000 acres in need of protection. Some land once farmed is for one reason or another being abandoned and allowed to return to forest or abandoned pasture. This presents an urgent need for extending fire protection to nearly twice its present area. Some additional aid may come from the Federal Government, but the bulk of the funds will have to come from state appropriations. Few, if any, private contributions will be made available to the state organization, although considerable fire fighting will always be done by private initiative.

FARM WOODLANDS IMPORTANT IN SOIL CONSERVATION

During recent years the place of farm woodlands in an integrated program of soil conservation has received increased attention. One of the most important problems in bringing existing woodlands to a productive condition is that of restoring a satisfactory growing stock of young trees. As a phase of this problem of regeneration, several experiments are being started in open, previously grazed woodlands; different methods of planting and various combinations of species are being tried.



A productive farm woodland which has been protected from fire and livestock grazing for over 20 years

Such a woodland is characterized by normal distribution of diameter classes, abundant tree reproduction, native woodland vegetation, and normal litter and humus layers.

HILLCULTURE RESEARCH UNDER WAY

Serious erosion has taken place in the steeper hill lands of Ohio because of the rapid runoff from long-denuded slopes and impoverished soils, and to meet this problem, the Muskingum Watershed Conservancy District has launched a comprehensive flood-control and water-conservation program which entails a tremendous investment in a system of dams and reservoirs. The future efficiency of these dams depends to a large extent upon the degree to which erosion in the watersheds supplying these reservoirs can be controlled. This means that the acreage of cultivated crops must be kept at a minimum.

Improved varieties of locust and nut trees have been widely spaced in a hilly bluegrass pasture field in southeastern Ohio.

The trees in the left foreground are spaced 1 rod apart; those on the right are 2 rods apart.

In view of these considerations, a so-called hillculture project has been initiated in cooperation with the Soil Conservation Service in order to attempt to develop a type of agriculture which will permit the continuation of livestock farming but will reduce cultivated crops to a minimum. This requires a substantial increase in pasture, but even grass sod has in many cases proved inadequate in holding soil and water on steep slopes, and landslips and gullying have often resulted. To remedy this situation it seems feasible that the grass covering of the steeper slopes might be supplemented with deep-rooted perennial vegetation, such as walnut, hickory, and black and honey locust trees, which are also capable of producing economic returns. General observations have also shown that pasture grasses seem to thrive better under walnut and locust trees, apparently on account of increased nitrogen contributed by the trees.

A study to determine the practicability of tree-pasture combinations was established on a 10-acre field in Guernsey County, Ohio, where black and honey locust and several varieties of nut trees were planted during April 1938 at spacings of 1 rod, 2 rods, and 4 rods. The species used consisted of black locust, shipmast locust, five varieties of thornless honey locust (noted for large pods of high sugar content), five varieties of improved walnuts, five varieties of improved hickories, three varieties of hicans, and three varieties of pecans. Plans include the conducting of intensive pasture experiments in this 10-acre field and a similar, unplanted check area.

START EXPERIMENTAL HARDWOOD PLANTATIONS

The forest planting program for Ohio should include the use of hardwood species on soils suited to their requirements. The native forest is composed almost entirely of hardwood species, and if site conditions warrant their use, the planting of these native species should result in establishing normal forest conditions sooner than the planting of evergreens. There are many sites, of course, where erosion or mismanagement has produced a subnormal condition and pines must be used. In the past, many plantings of hardwoods have been made on sites unsuited to them, and results have been unsatisfactory in many instances.

The selection of the proper species for a given site is one phase of this problem. Another, and equally important phase, is the determination of the proper mixture of the species to be used. Although it is commonly recognized that mixtures are advantageous, it is unwise to mix the various species at random, because of their different requirements. A study of this problem has been begun with an extensive series of plots at the Findley State Forest in southern Lorain County. Here plots have been planted with the common hardwood species in single and multiple row mixtures, and in a type of mixture in which the more valuable species is widely spaced and a secondary species is interplanted as a companion crop. An additional variation is the planting of the companion crop in some cases 3, 5, or 10 years later.

The plots are fairly large. All of them exceed an acre in extent, and most of them are over 2 acres. The large size makes possible a later subdivision of the plots for further management studies.

CONTINUE BLISTER RUST CONTROL WORK

Spread of the rust.—White pine blister rust infection on *Ribes* has been found in Ashtabula, Columbiana, Cuyahoga, Fairfield, Fulton, Geauga, Knox, Lake, Lorain, Portage, Summit, Trumbull, and Wayne Counties, principally on European black currant bushes. Infected white pine trees have been found in Ashland, Geauga, Holmes, Knox, and Wayne Counties.

A pine infection study plot established in Ashland County shows that 1.6 per cent of 437 white pines on 0.38 acre had become infected from 1930 to 1934. Apparently the initial *Ribes* eradication in September 1934 prevented further intensification of blister rust in this area.

Survey work.—Pre-eradication surveys show that there are approximately 3,100 acres of native white pine and 6,000 acres of planted white pine, or a total of 9,100 acres, to be protected from blister rust by the eradication of *Ribes* bushes on 120,000 acres in 900-foot zones surrounding each pine area.

Arrangements have been made to survey each white pine planting site before planting in order to avoid establishing white pine where the cost of eradicating *Ribes* bushes cannot be justified. White pine is being planted more extensively; approximately 78 per cent of the 3,504,000 white pine trees shipped out for reforestation have been planted during the last 10 years.

Cooperative work.—This work has been carried on in cooperation with the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Plant Disease Control, and other agencies.

THE WEATHER, 1937

(Similar data for previous years are to be found in Bulletin 592)

Both the temperature and rainfall for January were much greater than average. The temperature has been exceeded only five times during the past 49 years, and the rainfall was a new record totaling 8.98 inches as compared with 3.13 inches for the 49-year average. Much damage was done by flood waters, the result of rain falling on 17 days of the month.

February was about average, although it was somewhat warmer and drier than usual. Considerable damage resulted from a severe windstorm accompanied by hail and sleet which occurred on the twenty-first.

Considerable damage was done to wheat, clover, and alfalfa by freezing and thawing weather during March and April. Truck crops and oats were planted late because of heavy April precipitation.

The month of May was very wet, and the heavy rainfall prevented the seasonal planting of corn.

June and the first part of July continued wet with the result that wheat and hay harvests were hindered. Rainfall for July and August was deficient. Corn and other crops were well matured before killing frosts and freezing weather.

November was very cold and dry; December, colder than usual.

The high temperature of 92° F. occurred on July 8 and September 2. The low point was reached on December 11 when the thermometer registered 2° above zero.

Rain fell on 154 days during the year, and the total recorded depth of snow was 9.8 inches. There were 137 clear days, 142 cloudy days, and 86 days partly cloudy. The average wind velocity was 6.2 miles per hour. The last killing frost in the spring was on April 23, and the first in the fall, on October 14. There was, therefore, a very long growing season of 173 days as compared with a 49-year average of 153 days.

Precipitation at the Ohio Agricultural Experiment Station, 1937

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1	.....	.....	.....	.....	.....	.....	0.03	.....	.....	.....	.....	.....
2	0.11	.....	.....	0.09	.....	.....	.02	.....	.....	.....	0.01	.....
3	.06	.....	.....	.02	.....	0.03	.52	.....	0.30	T	.....	.....
4	T*	0.02	0.18	.....	0.04	.....	.....	.....	1.36	T	.....	T
5	.....	.15	.07	.17	.09	.....	.....	0.04	.31	1.65	.01	0.04
6	.....	.....	.....	.35	.67	.57	.02	.01	.....	.....	.....	.04
7	.33	.....	.....	.....	T	T	.....	.30	.....	.....	.....	.02
8	.05	.04	.....	.04	.....	T	.....	.....	.....	.....	.05	.03
9	.37	.40	.10	.....	.15	.....	.02	1.47	.....	.20	.08	.....
10	.40	T	T	T	.....	1.14	.06	.10	.....	.08	.....	.....
11	.....	T	.....	T	.....	.....	.07	.....	.08	.07	.....	.....
12	.....	.....	.....	.....	.05	.07	.24	.07	.....	.08	.....	.....
13	T	.....	T	.....	.24	.....	.11	.....	T	.25	.16	T
14	1.57	.23	T	1.20	.08	.26	.23	.....	.....	.....	.01	.....
15	.85	T	.10	.58	.29	.12	.13	.....	.02	.....	.10	.02
16	.....	.15	.05	T	.23	.....	.24	.....	.....	.....	.....	.45
17	.05	.....	T	.....	.12	.38	.31	.....	.....	.....	.07	1.29
18	.98	.05	.02	.13	T	T	.04	.....	.....	1.20	.....	.61
19	.....	T	.....	.07	.14	T	.....	.36	.07	.25	.18	T
20	.18	.05	.60	.....	.....	T	.....	.05	.....	.10	T	.02
21	.95	.25	.32	.69	.02	1.98	.....	.27	.....	T	T	T
22	1.25	.10	.....	.48	.07	.03	.....	.06	.....	.36	T	T
23	.40	.....	.....	.....	.77	.....	.....	.....	.....	.06	.....	.01
24	.63	.....	.27	.15	.....	.....	.....	.....	.....	.01	.....	.06
25	.66	.10	.24	.77	.....	.14	.99	.....	.20	.....	.....	.02
26	.....	T	T	.....	.10	.....	.10	.....	.28	.....	.04	.....
27	.....	T	T	.15	.42	.26	.....	.....	.....	.....	.01	.04
28	.....	T	.....	.....	.....	.....	.....	.....	.....	.....	.07	.01
29	.....	.....	.....	.....	.....	T	.....	.....	.....	.....	T	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	T	T
31	.14	.....	.....	.....	.04	.....	.....	.02	.....	.....	.....	.13
Total	8.98	1.54	1.95	4.89	3.52	4.98	3.13	2.75	2.62	4.31	0.79	2.79
Total for year												42.25

*T—Less than 0.01 in.

Climatological summary for Ohio and Wooster, 1937

Month	Temperature (degrees Fahrenheit)								Precipitation (inches)			Number of days—				Prevailing wind direction
	Monthly mean*	Departure from normal	Highest °F.	Highest Date	Lowest °F.	Lowest Date	Range	Greatest daily range	Average*	Departure from normal	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy	
Ohio																
January	35.9	+7.4	72	8	−9	23	81	40	9.42	+6.31	5.1	16	6	6	19	SW
February	31.6	+2.4	75	8	4	25	71	48	1.72	−0.84	3.3	10	6	9	13	SW
March	34.9	−3.8	75	20	2	10	73	42	1.65	−1.70	4.3	9	11	7	13	NW
April	49.7	0.0	90	23	20	12	70	51	3.95	+0.82	T	13	9	9	12	SW
May	60.5	0.0	96	31	29	11	67	46	3.70	+0.05	0	13	13	10	8	SW
June	69.7	+0.2	98	1	41	11†	57	39	6.07	+2.29	0	13	11	11	8	SW
July	73.2	−0.5	102	9	41	1	61	43	4.27	+0.48	0	11	15	11	5	SW
August	74.7	+3.1	103	17	48	2	55	44	3.20	−0.18	0	8	15	9	7	SW
September	63.0	−2.6	99	2	28	18	71	50	2.45	−0.53	0	6	17	8	5	SW
October	51.8	−1.6	91	1	19	15	72	47	3.39	+0.80	0.1	11	9	9	13	SW
November	39.4	−2.0	73	1†	7	21†	67	44	1.30	−1.42	2.1	9	9	7	14	SW
December	28.9	−2.7	62	31	−6	12	68	36	2.91	+0.16	3.4	13	7	4	20	SW
Annual	51.1	0.0	103	Aug. 17	−9	Jan. 23	112	51	44.03	+6.22	18.3	132	128	100	137	SW
Wooster																
January	35.0	+7.7	64	8	11	24	53	30	8.98	+5.74	5.0	17	5	8	18	SW
February	31.0	+3.5	66	8	8	25	58	40	1.54	−0.70	7.2	11	6	6	16	SW
March	33.0	−4.2	56	20	9	10	45	30	1.95	−1.63	2.8	10	7	8	16	NW
April	47.6	−0.5	70	24	24	10	46	38	4.89	+1.68	.....	14	7	8	15	SE
May	58.6	0.0	88	31	34	7	54	38	3.52	−0.13	.....	17	14	10	7	SW
June	68.2	+0.4	87	5	42	12	45	35	4.98	+1.12	.....	11	15	9	6	SW
July	71.9	0.0	92	8	46	28	46	34	3.13	−0.93	.....	16	20	9	2	SW
August	73.2	+3.4	91	17	50	2	41	34	2.75	−0.97	.....	11	21	7	3	SW
September	61.4	−2.7	92	2	32	18	60	45	2.62	−0.66	.....	8	20	6	4	SW
October	51.4	−0.5	83	1	24	6	59	33	4.31	+1.71	0.1	12	9	6	16	SW
November	38.9	−1.4	65	7	13	23	52	35	0.79	−1.74	3.0	12	9	4	17	SW
December	27.8	−2.7	49	31	2	11	47	27	2.79	0.00	1.7	15	4	5	22	SW
Annual	49.8	+0.2	92	July 8†	2	Dec. 11	90	45	42.25	+3.54	19.8	154	137	86	142	SW

*Totals given for Wooster.
†On other dates also.

PUBLICATIONS

During the year from June 30, 1937, to July 1, 1938, the Ohio Agricultural Experiment Station published 11 bulletins, 3 special circulars, 6 bimonthly bulletins containing 44 articles, and 53 press bulletins containing 216 news releases. The Experiment Station Press printed a total of 11,477,700 pages

Staff members wrote 64 articles for publication in outside journals during the year.

Copies of Experiment Station publications can be obtained by writing to the Mailing Room, Ohio Agricultural Experiment Station, Wooster, Ohio.

BULLETINS

No. 583 Codling Moth Biology and Control Investigations. C. R. Cutright. July 1937. 45 pages. 19 figures. 9 tables.

In this bulletin the author summarizes facts discovered in a study of codling moth biology and shows how orchardists can use these facts in the control of codling moth, also how the discoveries have been of use in the research program in perfecting methods of control. He describes experiments in codling moth control, including spraying with different materials and supplementary control measures.

584 Removal of Spray Residue from Apples. C. W. Ellenwood, V. H. Morris, and E. A. Silver. July 1937. 40 pages. 5 figures. 29 tables.

This publication presents some of the results of the spray residue work undertaken in 1935 and 1936. An effort was made in this work to determine the probable amounts of residue that result from a number of different spray programs commonly used in Ohio and to determine the effectiveness of methods and equipment that have already become more or less standard in removing the spray residues. In presenting the data in this bulletin, the authors have kept in mind the possible practical value to the applegrowers of Ohio.

585 The Effect of Land Use and Management on Erosion. E. H. Reed and J. I. Falconer. July 1937. 19 pages. 1 figure. 20 tables.

This bulletin presents the results of a study the purpose of which was to determine in a limited area some of the factors within the control of man which had contributed to erosion. This study points out the importance of quality of farming and management, as well as organization and land use, as factors in erosion control.

586 Greenhouse Potted Plants. G. H. Poesch. September 1937. 60 pages. 12 figures. 10 tables.

The discussion of the major potted plants and their culture presented in this bulletin is based on the best accepted commercial practices and the results of experiments conducted for several years at the Ohio Agricultural Experiment Station and The Ohio State University.

587 The Farm Business from 1929 to 1935 on One Hundred Forty-One Ohio Farms. J. H. Sitterley and J. I. Falconer. October 1937. 22 pages. 3 figures. 14 tables.

The authors observe some of the effects of the changing conditions between 1929 and 1935 on net cash income, record the recognizable adjustments made, and attempt to determine, in so far as possible from the records, some of the characteristics of those farms that obtained the largest and those that obtained the smallest incomes during this period.

588 Better Methods of Seeding Meadows. L. E. Thatcher, C. J. Willard, and R. D. Lewis. December 1937. 61 pages. 40 figures. 18 tables.

Any program of increasing the proportion of land in soil-building sod crops must first of all attack the problem of obtaining seedings. Because of the vital importance of this problem, an important part of the experimental work of the Department of Agronomy during the last 10 years has consisted of tests at Wooster, Columbus, and the outlying experiment farms designed to study the principles involved in obtaining seedings. The results of this experimental work, together with practical seeding suggestions, are reported in this bulletin.

589 Soil Erosion in Ohio. G. W. Conrey, J. S. Cutler, and A. H. Paschall. December 1937. 32 pages. 10 figures and 1 large map insert. 7 tables.

This bulletin is designed to present the extent of the erosion problem in Ohio and to point out in a general way the relationship of erosion to land use. A generalized erosion map of the State is included.

590 Tobacco Cultural and Fertility Tests. M. A. Bachtell, R. M. Salter, and H. L. Wachter. January 1938. 30 pages. 7 figures. 24 tables.

The tobacco investigations of the Ohio Agricultural Experiment Station have covered a wide range of fertility and cultural practices with the result that there is now available information concerning most of the phases of tobacco growing from the time the plant beds are started until the mature plants are cut and hung in the barn. Such information is presented in this bulletin.

591 Spraying Program and Pest Control for Fruit Crops (also published as Bulletin 128 by the Agricultural Extension Service, The Ohio State University). January 1938. 52 pages. 19 figures. 14 tables.

This bulletin discusses the standard spray materials now offered for sale and suggests proper combinations that will control both insects and diseases without causing spray injury to the fruit and foliage. It has been prepared after considerable discussion of the effectiveness and safety of the materials and combinations suggested, and these have been thoroughly tested and approved.

592 Progress of Agricultural Research in Ohio, 1936-1937 (the Fifty-sixth Annual Report of the Ohio Agricultural Experiment Station). May 1938. 142 pages. 15 figures. 76 tables.

This publication contains the report of the Director of the Ohio Agricultural Experiment Station and includes accounts of the experimental work carried on during the year by the Experiment Station Departments of Agronomy, Animal Industry, Botany and Plant Pathology, Dairy Industry, District and County Farms, Home Economics, Rural Economics, Agricultural Engineering, Entomology,

Forestry, and Horticulture. It lists the publications of the Ohio Station during the year and includes a climatological summary of the year 1936, as well as the report of the Station Bursar.

593 Ohio Agricultural Statistics, 1936. Glenn S. Ray, L. H. Wiland, and P. P. Wallrabenstein. May 1938. 62 pages. 1 figure. 99 tables.

This bulletin contains preliminary county estimates of the acreage, yield per acre, and total production of corn, winter wheat, oats, tame hay, and potatoes for 1936; revised estimates of tame hay for 1929 through 1935, corn for 1935, and potatoes for 1935; preliminary county estimates of the numbers of livestock on farms January 1, 1937, and revised estimates for the numbers on hand January 1, 1935. It includes also revised figures for all tame hay, annual legume hay, soybeans, hay seeds, and the number of cows and heifers 2 years old and over kept mainly for milk; these have become available since the publication of the previous statistics. Included in this bulletin also are reports of average Ohio farm wages by the month and by the day, farm prices of Ohio farm products, and the estimated gross cash income of Ohio's agricultural industry from the sale of products and government payments for the period 1910-1936.

SPECIAL CIRCULARS

No. 44 (revised) A Key to the Soils of Ohio. G. W. Conrey, A. H. Paschall, and E. M. Burrage. March 1938. 51 pages. 1 figure. 15 tables.

It was the aim of the authors of this circular to summarize the characteristics of the important soil types in Ohio and to present data concerning their natural and possible productivity.

50 Welcome to Ohio! May 1938. 4 pages. 1 figure.

This circular is a guide to the locations of State-owned dairy herds with which extensive breeding or feeding programs are being conducted in Ohio. It was published for the meetings of the American Dairy Science Association held in Ohio in June of 1938.

51 Time- and Labor-saving Equipment for the Laying House. D. C. Kennard and V. D. Chamberlin. July 1938. 8 pages. 7 figures.

Equipment and devices designed to ensure better care of layers and to save time and labor in their care are described in this circular.

BIMONTHLY BULLETINS

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191 March-April, 1938
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Evaporation Studies. II. The Influence of Pan Color on Evaporation
Announcement of Special Days for 1938
The Ultraviolet Absorption Spectra of Some Monoazo Dyes
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REPORT OF THE BURSAR

July 1, 1937, to June 30, 1938

Consolidated Statement

ASSETS AND LIABILITIES

ASSETS

Current assets June 30, 1938	$ 116,825.14	
Contingent assets	203,878.62	
Land	691,268.76	
Land improvements	69,630.61	
Buildings	668,191.68	
Departmental equipment	537,251.40	
Total assets		$2,287,046.21

LIABILITIES

Capital account	$2,083,167.59	
Special State appropriations	203,878.62	
Total liabilities		$2,287,046.21

INCOME AND EXPENDITURES

INCOME

Cash balance July 1, 1937	136,975.64	
Appropriations by State Legislature	379,667.74	
Appropriations by United States Government	167,504.07	
Sale of produce, etc.	103,800.76	
Total income		787,948.21
Less funds paid to State Treasurer and not available for use by the Station		215.84
Total available income		$ 787,732.37

EXPENDITURES

Salaries	$ 334,506.87	
Employees and extra labor	134,029.34	
Stationery and office supplies	3,239.72	
Incidentals	6,721.29	
Laboratory supplies	5,213.75	
Materials and general supplies	56,539.16	
Repairs to equipment	10,308.35	
Telephone and telegraph	2,643.67	
Freight and express	2,849.56	
Travel	6,693.32	
Feed	42,244.51	
Fertilizers	1,452.24	
Apparatus	7,468.42	
Furniture and fixtures	750.52	
Machinery, tools, etc.	18,339.06	
Library	981.75	
Livestock	14,753.92	
Land	20,633.98	
Land improvements	1,537.80	
Total expenditures		$ 670,907.23
By balance forward		116,825.14
Total		$ 787,732.37

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[1]In cooperation with College of Agriculture, Ohio State University.
[2]In cooperation with the U. S. Department of Agriculture.